GOOD GROWING WEATHER

THE HANDBOOK FOR PRACTICAL FARMERS

DEALING WITH THE MORE IMPORTANT ASPECTS OF FARMING IN THE UNITED STATES

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SPECIAL CHAPTERS DEALING WITH FARM PROBLEMS AND PRACTICES BY PRACTICAL EXPERTS IN DIFFERENT PARTS OF THE UNITED STATES

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PREFACE

The leaders in American farm-life to-day realize that the farmer must be not only a good business man, but he must also be acquainted with the science of agriculture. Therefore this book aims to deal with the business side of farming and to assemble the scientific knowledge of agriculture as studied and practiced by a number of experts.

In order to make this practical knowledge more accessible to the farmer, technical terms have been eliminated and an easily comprehended terminology has been maintained throughout the book.

The author is indebted to many experiment stations for their cooperation in supplying information and illustrations, credit for which is given in the pages of this book.

He is particularly pleased to acknowledge his deep obligations to the International Harvester Company, the Du Pont Powder Works, and the Gould Force Pump Company, for their contributions.

Grateful acknowledgment is due the *Country Gentleman,* the *Wisconsin Farmer,* Doubleday, Page & Co., and the Macmillan Company for extracts taken from their publications.

The U. S. Department of Agriculture has given valuable service to the editor in furnishing material and in supplying bulletins from which extracts and illustrations have been taken.

The farmer and his family are the most potent factors in making the United States the greatest producing nation as well as the greatest nation of happy homes. It is therefore hoped that this book will aid in increasing production and happiness among the tillers of the soil.

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CHAPTER I

SOIL MANAGEMENT

BY A. G. McCALL, Ph.D.[1]

Good and poor soils.— A good soil is one that is capable of producing a satisfactory crop under favorable climatic conditions. Most of our soils are quite fertile and produce profitable crops when they are first brought under cultivation, but it is a matter of common experience that continued cropping results in a loss of fertility as indicated by a steady decline in yields. This decline in yield continues very slowly and gradually until the crop finally becomes so small that it no longer pays for the labor and cost of production and at this point the soil has become exhausted for all practical purposes. Under proper systems of management, however, virgin soils may be made to retain their productive capacity indefinitely and old worn lands may be restored to permanent fertility.

The intelligent use and the proper management of the soil is based on an understanding of its composition and its structure. A good soil is composed largely of two parts: (1) The *organic matter* derived mainly from the plants that have previously grown upon the land and that have become more or less decomposed; (2) *inorganic matter* derived originally from the rocks that have broken down to form the soil. Both the organic matter and the inorganic material play an important part in determining the fertility of the soil. Dark-colored rich loam soils are usually well supplied with organic matter while the poor light colored soils are deficient in organic material, and the restoration of organic content constitutes one of the first steps in the restoration of fertility. The inorganic part is made up of fine rock particles of all sizes from coarse sand or gravel to those so fine that they can not be seen with the naked eye.

A good soil may be distinguished from a poor soil by the general appearance and by the character of the plant growth which it supports. From the oldest time down to the present, black soil has commanded the attention and the approval of practical farmers for the reason that the black color is usually the result of the presence of an abundant supply of organic

[1] Maryland Experiment Station.

matter. In some sections the black color also indicates the presence of an abundant supply of lime which is also essential. Next to the black soils the reddish brown lands will usually prove to be highly productive and will command the respect and approval of practical farmers. Yellow lands are usually next in value, while the white and the gray colors are not regarded as indicative of naturally fertile soil. In dry arid regions, very white spots usually indicate the presence of harmful amounts of alkali salts.

The presence of well developed oaks or of hickory and walnut trees are evidence of a naturally fertile soil, while a growth of soft woods such as gum and short-leaved pine indicates a poor soil. On cultivated fields the thrifty appearance of the crop plants or a rank growth of weeds may be taken as a reliable guide as to the fertility of the soil. Soils that are practically useless for general farm crops, however, may be well adapted to the growing of special truck crops for the early market. Light sandy soil is best adapted to the growing of early vegetables, small fruits, potatoes and other similar crops, while the heavier loams are best suited to the growing of corn and other grains. Clay soils are best adapted to the growing of wheat and grass, because of their greater moisture holding capacity. The classification of soils with respect to their adaptability to different crops is based largely upon the size of the rock particles of which the soil is composed and to a lesser degree upon the amount of organic matter present.

In farm practice soils are spoken of as being heavy or light depending upon whether they are hard or easy to work. Clay soils are difficult to till because of the fineness of the particles and their tendency to stickiness, while coarse grained sandy soils are easily cultivated because of the absence of any large quantity of material that is finely divided. All soils, however, are mixtures of different sized particles, the *size* of the individual particles determining the *texture* and their *arrangement* the *structure* of the soil. When the arrangement of the soil particles, or the structure is such as to be highly favorable to the growth of crops the soil is said to be in good tilth.

Relation of texture and structure to soil management.— A great majority of soils consist of particles varying in size from very fine to coarse, although some have only fine and others only coarse particles. The coarse particles are classed as fine gravel or coarse sand; the next finer groups as medium sand, fine sand, very fine sand; the finest as silt and clay. The rela-

tive amounts of these different groups vary widely in different soils, the relative predominance of the fine and the coarse particles determining whether a soil shall be classed as fine textured or as coarse textured. Soils that contain a large proportion of clay are called clay soils; those containing a large proportion of sand are classed as sandy soils; those that are intermediate are called loam soils. A loam with a slight excess of clay is known as a clay loam; one with an excess of silt a silt loam.

Various other names, such as sandy loam, fine sandy loam, or gravelly loam, are applied to soils of different texture. In the soil survey reports certain proper names are prefixed to further describe certain soil types, as Leonardtown Loam, Miami Clay Loam, Cecil Clay, and Penn Shale Loam. The coarser soil has less pore space than the fine textured soil, hence it has a greater weight per cubic foot. A cubic foot of dry sandy material weighs from one hundred to one hundred and ten pounds; of loam from seventy-five to ninety pounds; and of clay soil sixty to seventy pounds. The average soil is usually estimated as weighing two million pounds per acre of soil taken to the bottom of the plow line, or about six and two-thirds inches. The term "heavy soil", however, is frequently used when referring to a soil that is difficult to work, such as a clay or a clay loam. Such soils are difficult to work because they are sticky and plastic when wet and become very hard when dry. On the other hand, sandy soils are called "light" by the farmer because they are easily worked.

The fact that certain classes of crop plants are better adapted to certain kinds of soils does not mean that these crops cannot be grown on other soils, but the successful farmer should select the crops that can be produced most profitably on his particular land. However, by the intelligent use of lime, manure and good cultural methods he may fit his land for crops to which it is not naturally well adapted. For instance, by the application of lime and the plowing down of green manuring crops or heavy applications of stable manure a heavy clay soil may be changed to a friable loam. On the other hand, the use of large amounts of organic matter on a sandy field will increase its moisture holding capacity and make possible the growing of crops that are not naturally well suited to sandy land.

When the fine particles of the soil are grouped together in granules they form a crumb structure that makes the soil loose and friable. It is then said to have good tilth or to be in a good physical condition. If these granules or crumbs become broken

down the soil may lose its loose friable structure and take on a poor physical condition. Plowing a field when it is too wet breaks down the crumb structure and puddles the soil, causing it to form hard clods and making it difficult if not impossible to prepare a good seed-bed. Old poorly farmed land that has been depleted of its organic matter is very difficult to keep in good tilth and may become very compact at the surface as the result of heavy beating rains.

The following treatments are most effective in bringing old worn lands back into good condition and keeping them in good tilth after they have been restored: (1) Plowing in the fall and winter and thus exposing the soil to alternate freezing and thawing in the northern states; (2) working organic matter such as stable or green manures into the soil; (3) providing good drainage; (4) applying liberal amounts of lime; (5) plowing down clover or grass sod frequently; and (6) working the soil only under proper moisture conditions.

The ease with which a soil can be tilled is very frequently a matter of as much importance as the question of fertility and is dependent on the texture and condition. Soils of fine texture are much more difficult to keep in condition than sands and sandy loams. The latter can be plowed earlier in the spring and worked with much more water in them than can the clays and clay loams. Similarly, soils that are rich in organic matter, such as sod land, can be plowed earlier and worked under a wider range of conditions than soils that are deficient in organic matter.

Pore space and soil moisture.— The space occupied by the soil is taken up, partly by the soil particles themselves, partly by air, and partly by water. About one-third of the total space occupied by sand and about one-half of that occupied by clay is taken up by the soil particles themselves, the remainder being occupied by air if the soil be dry. For the best growth of crops about half of the space not occupied by the soil particles should be taken up by water. For the proper growth of staple farm crops, a fertile soil must have a certain proportion of these constituents at all times. If there is too much soil there may be a deficiency of water or air or both, while if there is not sufficient soil the pore space may be so great as to permit the leaching out of plant food materials and the soil will be unable to retain sufficient moisture to meet the demands of the growing crop. Heavy clay soils have a larger total volume of pore space than sands, but the individual spaces are so small that they are more

effective in absorbing and holding the moisture than are coarser grained materials. When puddled by wet plowing or poor management the pores may become so small that water is held so tenaciously that it is of little use to the crop. The following table gives the proportion of pore space in some common classes of soils:

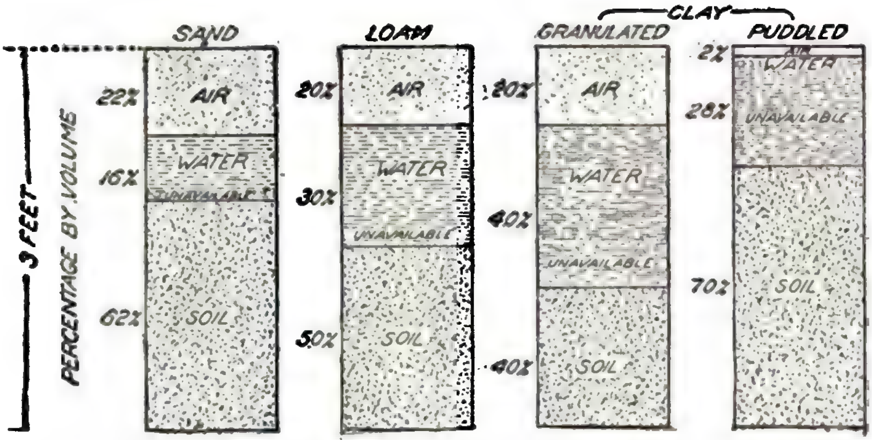

FIG. 1.—Diagram representing the proportion of space occupied by soil material, water, and air in a section of different soils. The availability of the soil water and presence of sufficient air are dependent on the right physical conditions of the soil.

PORE SPACE IN SOIL

KIND OF SOIL	PROPORTION OF PORE SPACE	
	Percentage	Parts by volume
Clean beach sand	35 to 40	1/3 to 2/5
Sandy loam. Good tilth	40 to 50	2/5 to 1/2
Sandy loam. Puddled	20 to 40	1/5 to 2/5
Silt. Good tilth	45 to 55	3/7 to 5/9
Clay. Good granular tilth	50 to 65	1/2 to 2/3
Clay. Puddled	25 to 45	1/4 to 2/5

The importance of the right proportions of the soil constituents and their relation to texture and structure is shown in the diagrams of Figure 2, which is taken from a Cornell reading course bulletin.

Soil moisture and crop production.—It is a matter of common observation that crops make a much better growth in a moist soil than in a soil that is too dry. The quantity of water used by a growing crop is very large and varies considerably with dif-

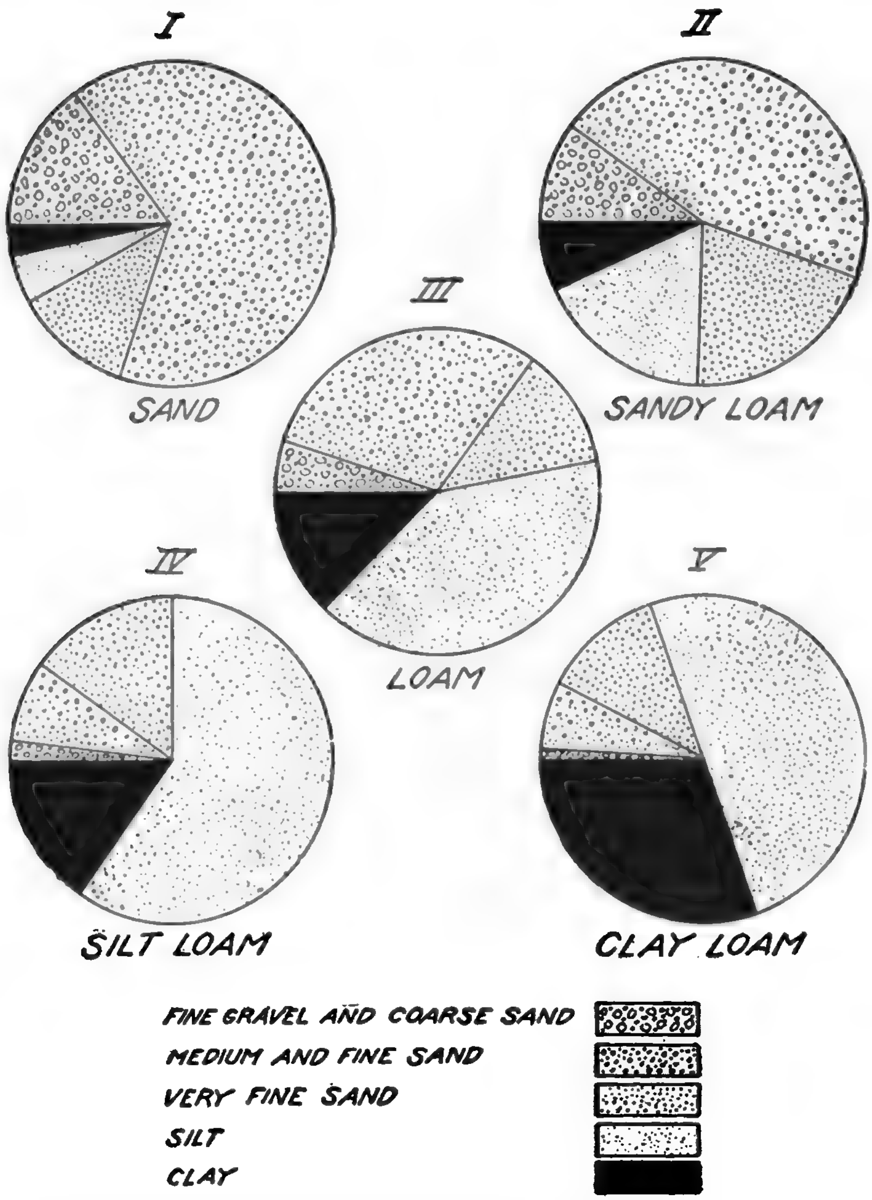

FIG. 2.—Diagrams representing the textural composition of the more important classes of soil, and the proportion of particles of different sizes that make up each kind.—*Cornell Reading Course.*

ferent plants. By comparing the amount required to produce a crop with the total annual water supply and taking into consideration the capacity of the soil to retain water for the use of the plant, appropriate steps may be taken to conserve the supply by proper methods of management and thus secure larger crop yields. While the quantity of water varies not only with the kind of plants but also with the climate and season, the following table gives the approximate amount of water necessary to produce a pound of dry matter and the number of inches of rainfall necessary to supply the needs for the yields indicated.

AMOUNT OF WATER REQUIRED TO PRODUCE CROPS

CROP	WATER REQUIREMENTS PER POUND OF DRY TOPS (pounds)	YIELDS PER ACRE		INCHES OF RAINFALL USED
		Bushels or tons	Total lbs. dry matter	
Corn	250– 375	100	10,000	11–16
Wheat	250– 500	40	6,500	7–14
Oats	400– 600	70	7,000	12–18
Potatoes	300– 450	300	6,000	8–12
Alfalfa	600–1000	6	10,000	26–45
Red clover	300– 500	4	7,000	9–15

Not only the total amount of rainfall, but its distribution throughout the growing season must be taken into consideration. Throughout a greater part of eastern United States the rainfall is sufficient for profitable crop yields if proper steps are taken to conserve the moisture. In the dry regions of the west special dry-farming methods must be followed to conserve the scant rainfall and insure its storage in the soil until it is used by the crop. In other sections of the west irrigation is practiced to supplement the rainfall. In the east the limiting factor, so far as water supply is concerned, is the capacity of the soil, either naturally or under the good management of the farmer, to retain sufficient moisture within reach of the plant roots to carry them over periods between rains.

When rain falls upon the surface of a field a part of the water soaks into the soil and another part runs off the surface. If the surface is dry and hard a very large proportion of the water runs off and only a small quantity enters the soil. The part that runs off the surface is not only lost to the plants, but it also carries away with it a large amount of plant food material and may even produce serious erosion of the surface soil. Observe

what happens when a hard rain falls on a loose mellow garden soil and compare this with what happens when the same rain falls on a hard path or other compacted soil. Thrifty farmers try to keep their fields loose and mellow on the surface during the growing season so that the soil will absorb and hold the rainfall.

The water that passes into the soil spreads out into a thin film over the surface of the soil particles, the amount of moisture retained depending upon the size of the individual grains and the surface which they present. A light sandy loam in good tilth will retain in the surface three feet about six inches of rainfall; silt and clay loams from eleven to fifteen inches, and a black muck soil as much as seventeen inches. Not all of this moisture that is retained is available to plants because of the tenacity with which it is held by the soil grains. In heavy clays and clay loams not more than half of the moisture retained is available, while in the sandy loam a much larger percentage can be utilized.

FIG. 3.—Soils that have a tendency to bake and crack should have frequent shallow cultivation to conserve the moisture.

The first duty of the farmer is to keep his soil in condition to absorb the rainfall and then to practice a system of management best calculated to retain the moisture and make it available to his crops. Since coarse sandy soils are inclined to be lacking in retentiveness, they should be kept as compact as possible. Such soils are better plowed in the fall than in the spring, and if humus is not being applied, shallow plowing is better than

deep, since the operation of plowing tends to loosen the soil. Plowing sandy soils when they are a little wet forces the smaller particles into the larger spaces and thus increases the quantity of water retained. The most effective means of increasing the moisture capacity of sandy land, however, is by the application of humus or well rotted organic matter and its thorough incorporation into the deeper layers of the surface soil.

The addition of humus is most effective when used in connection with deep plowing followed by compacting implements such as the roller, the effect of the humus more than compensating for any disadvantages from deep plowing.

In very fine textured soils, such as clay and in loams that are puddled, the pores are so small in size, and sometimes also in total volume, that the soil has a very low moisture holding capacity. Great care must be exercised in the management of such soils, since it is important that they should be kept in a loose granular condition. The finer the soil the greater the importance of putting it in a granular condition. In coarse sandy soils the individual particles may rest close together and yet the pore spaces be too large to be most effective. On the other hand, if a clay soil is pulverized so that the individual particles rest close together, the spaces are so small that they retain too much moisture and thus cut off ventilation and lessen the rate of formation of available plant food material.

Practical hints on tilth and tillage.— Since good tilth is dependent upon a proper degree of granulation it is desirable to study some of the factors affecting granulation.

1. Adequate drainage is the most fundamental of these. It is impossible to keep a poorly drained soil in good tilth. Such a soil is naturally inclined to puddle and compact, and when dry works up into a rough, lumpy condition. Continual wetness breaks down the granular aggregates by dissolving the cementing material, and permits the particles to settle together. The first step toward improvement of soil that is too compact is provision for good drainage by some means, preferably by tile underdrains.

Drainage quickly removes excess water and permits a reasonable amount of drying, which results in cutting and granulating the soil by means of checks and cracks. Without any other treatment, drainage will loosen the soil and provide an improved circulation of water and gases throughout the earth mass. In proof of this is the observation of farmers that underdrains in heavy soil gradually increase in efficiency over a period of years.

This mode of action has been described as a "slacking" of the soil, although technically it is a different process. The earth seems to fall apart and loosen to such an extent that certain persons have thought they noticed an elevation of the surface adjacent to the lines of drain. Too much emphasis cannot be placed on the fundamental value of drainage in improving the physical condition of compact soils.

FIG. 4.—Cutting, pulverizing and compacting the seedbed at one operation.—*By permission of Dunham Co., Berea, Ohio.*

2. Tillage of soil that contains only capillary (film) water is very helpful. If the soil is either too wet or too dry the best results cannot be obtained. That nicely moist condition in which a mass of moist soil pressed in the hand will hold its form but will not show free water, is the right stage for proper tillage. When too dry, a soil breaks into chunks, or clods, that must be broken down.

3. Plenty of decaying organic matter in the form of *humus* is very helpful in developing good tilth. Humus is a dark-colored, gelatinous substance that in many ways helps to produce granular structure. The tendency of soils to settle and bake after years of cultivation is often due to exhaustion of the

organic matter. This in turn reacts on the physical and drainage condition of the soil in a way which is doubly injurious. The maintenance of humus in the soil is one of the most effective means of improving the tilth. This applies to sandy land quite as much as to clay land, but in sand the mode of action is different from the process of granulation.

4. Lime has a peculiar effect on clay soils. The fine particles are thrown together in groups or floccules and when the soil dries these become granules. Clay soils rich in lime carbonate have sometimes been mistaken for sandy soils because of this action. Clay soils that have been granulated work more easily

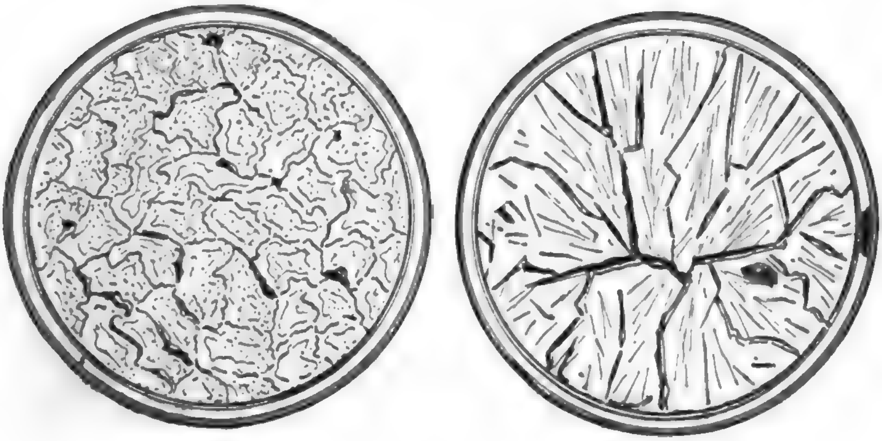

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FIG. 5.—These figures represent two pans of clay soil which had been puddled and molded with a smooth surface. While still wet, pan No. 2 was permitted to freeze. Both pans were permitted to dry out. The cracks formed where the structure of the soil was most open. The pattern in No. 2 shows the influence of the ice crystals, and this soil was much more friable and crumbly than the soil that was dried without freezing.

than those that have not. An English farmer is reported to have said that liming his clay land enabled him to plow with two horses.

5. Alternate freezing and thawing breaks up heavy soils. As water freezes in the soil, long, needle-like crystals are formed that cut through the soil in many directions. So complete is this network of crystals and so effective is their cleavage action that the hardest clod rarely fails to fall to pieces after two or three severe freezes. Nothing is more effective in breaking up subsoils than deep fall plowing which leaves them exposed to the action of frost during the winter. To be most effective, however, the fall plowing should be accompanied by good drainage,

which will help to prevent the soil from running together during the spring thaws.

6. Penetration of roots, and the burrowing of earthworms, ants and other animals are important agencies in soil improvement. The roots of plants make their way through the soil in every direction, the crops having fine fibrous roots like the buckwheat, being especially noted for their beneficial effect on heavy soil. It is generally conceded that the best way to bring a poor clay soil into condition is to put it down to grass for a few years, after which it turns up loose and friable. The mat of vegetation formed by plants, especially grasses, protects the soil from beating rains, the puddling action of melting snow, and from washing or erosion. Plants grown for the purpose of protecting the surface of the soil are known as cover crops.

In order to accomplish good plowing the furrow slice must be turned to the proper angle and should be straight and uniform. To set the furrow slice at the proper angle it is necessary that the depth of the plowing should be about one-half the width of the furrow. If the plowing is too shallow the furrow slice is inverted. When the furrow slice is completely inverted, stubble and sod or rubbish are thrown to the bottom of the furrow where they tend to prevent the proper contact of the furrow slice with the subsoil. If, on the other hand, the furrow slice is set well on edge, there is a good chance for the capillary rise of moisture, rainfall is more readily absorbed, and the sod and rubbish are more evenly distributed throughout the depth of the furrow. When the soil bears a heavy sod so that the furrow holds its form, packing by heavy rolling is desirable, so as to bring the sod in closer contact with the subsoil and to eliminate intersoil spaces that are too large. The diagrams of Fig. 3 show the proper position of the furrow slice after it has been turned by the plow.

The average depth of plowing in the United States is probably not over five inches. For most soils, especially those having a compact subsoil, deeper plowing is highly beneficial since by this means their moisture capacity may be greatly increased and deeper root penetration secured. On light, sandy soils deep plowing should be accompanied by generous applications of manure or other organic matter.

Several attachments are used on the plow for special conditions of the soil. On sod land the jointer much improves the result. This is a miniature plow which cuts the surface roots and turns under the edge of the furrow, giving a smoother

appearance. It tends also to prevent grass from growing along the soil line of each furrow.

Several types of colter are used on sod or rooty ground for cutting the furrow from the landside. All these should be placed

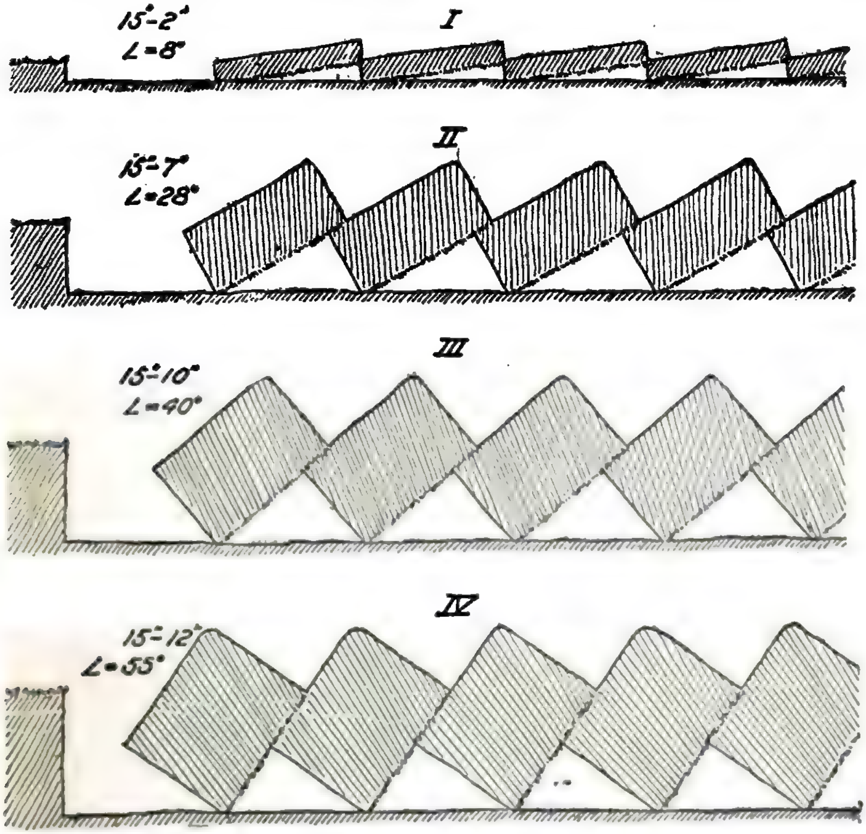

FIG. 6.—Diagrams illustrating the effect of depth of plowing relative to width of furrow on the final position of the furrow slice. The second and third are the most satisfactory. When set in this position the upper edge of the furrow slices may be readily worked down to a seed bed without the interference of sod which may have been turned under. Manure and turf are well distributed, without breaking connection with the subsoil. Subsequent packing and preparation should break down the lower edge of the furrow slice and bring the top soil in close contact with the subsoil.—*Cornell Reading Course.*

a little back of the plow point and slightly outside the line of the landside, so as to cut a clear course at the moment when the roots are drawn taut over the point. The rolling and blade colters are attached to the beam. The rolling colter adds less to the draft, and is more satisfactory than the blade colter where there is much surface rubbish. Occasionally a small fin colter

is attached to the share. When the shin of the plow is sharp, especially on fallow ground in good condition, colters are of little service, and the jointer in particular is objectionable owing to the increase in draft.

There are two types of turning plow, the moldboard and the disk. The former is in most general use and is adapted to the widest range of soil conditions. The disk plow is especially suited to hard, dry soil and does particularly well where there is much rubbish or vegetation to be turned under. It is not adapted to sod land or to soil that is very stony.

On hard soil the disk plow is more efficient than the moldboard plow for the draft consumed.

Subsoiling.—Subsoiling is the operation of breaking up the subsoil without turning it to the surface. A special plow is used in the bottom of the furrow behind the turning plow. Subsoiling is practiced most safely in the fall. Unsatisfactory results are likely to follow subsoiling in the spring.

Deep-tilling implements.—An intermediate implement between the turning plow and the subsoil plow is the Spalding Deep-Tilling machine. This is of the solid disk type. There are two disks, one behind and below the other. They are carried on a sulky frame, and by proper adjustment the soil can be worked twelve to sixteen inches deep. Its use appears to be relatively more safe than would be plowing with the moldboard plow to the same depth, for, although the subsoil is stirred, it is only partly thrown to the surface and mixed with the topsoil. In order to accomplish the mixing of the right proportions of subsoil with the soil, special attention must be given to the relative amount of cutting done by the two disks.

After plowing, the soil should usually be worked down and pulverized at once. At that time the lumps are most easily pulverized, and by leveling and fining the surface moisture is saved. In the case of fall plowing this practice is not recommended, as the rough surface holds the snow during the winter and is less subject to puddling during the spring thaws. Cultivators stir the soil. For rapid work some type of harrow is generally used.

The harrow is a broad, many-toothed implement, generally without wheels or guiding handles. There are three main types of harrows: the spike-tooth, the spring-tooth, and the disk. The spike-tooth harrow is light, and is therefore suited to rather clean soil in fairly good condition. The spring-tooth harrow draws to the ground better than does the spike-tooth harrow.

It works to greater depth and tends to bring lumps and stones to the surface and to collect roots and vines. Usually the slant of the teeth of the spike- and spring-tooth implements can be readily adjusted, and this determines the extent to which they stir the soil.

Something more vigorous than a harrow is sometimes required on lumpy soil; grinding and crushing action is most effective. For pulverizing and leveling the surface, the plank drag is effective.

FIG. 7.—The plank drag smooths and levels the surface. An efficient home-made implement.—*By permission of Dunham Co., Berea, Ohio.*

The most common tool used to pack the soil is the roller, of which the log roller is the pioneer type.. The value of the roller depends largely on its weight and diameter. For the same weight the smaller diameter is more efficient than the larger diameter. The roller is often used immediately after plowing to press down the furrow slices so that they will not be torn up by the harrow and so that a more level surface is provided for the team. In countries where the winters are severe and the roots of plants are torn loose from the ground by frost, the roller is used in order to press roots into the soil and to firm the soil

around the roots so that they may renew their growth. Rollers usually are made in two or more sections for convenience in turning, and have a basket or some other arrangement for loading in order to increase the weight. As a pulverizer the solid roller is inefficient. Its weight is distributed over too much surface and it is likely to press the clods into the soft soil rather than to crush them.

Another type of roller is the subsurface packer, which comes near to being an ordinary clod-crusher. Its surface is broken

Fig. 8.—This corrugated roller is an effective pulverizer and at the same time makes a compact seedbed.—*By permission of Dunham Co., Berea, Ohio.*

so that it cuts into the soil and exerts pressure to considerable depth. It is especially useful in the spring of the year and in arid regions, in pressing the furrow slice into close contact with the subsoil and at the same time leaving a loose layer of soil on the surface as a mulch to save water.

Farm manures and commercial fertilizers.—To the practical farmer there is no question of greater importance than that of soil fertility. Good farm management consists in producing profitable crops and at the same time maintaining or even increasing the productive capacity of the soil. Many farmers

are accomplishing this result by making use of the knowledge which they have acquired through years of experience and a study of the character of their land, its adaptability to crops, and methods of management and manuring. Other farmers have accomplished the same results in a much shorter period of time by acquiring a definite knowledge of the fundamental principles and making use of the experience of others.

Grain and livestock farming.— In the system of grain farming that has been practiced over large areas in this country for long periods of time, and is still practiced, the livestock is often limited to the number needed for labor, the grain is sold and only the straw and stalks returned to the land. Where a part or all of the grain produced is sold from the farm it becomes a necessity sooner or later to supply plant food materials from outside sources and to make provision for keeping up the supply of organic matter in the soil by plowing down sod and by the growing of green manuring crops to be plowed down.

In livestock farming the same results are accomplished by feeding the crops grown on the farm and saving the manure and returning it to the land. If in addition to feeding all of the crops grown on the farm, concentrated feeds are purchased and fed, the loss of soil fertility may be reduced to a minimum, or there may result an actual gain in fertility.

This system of farming is even more effective if some of the produce that is low in fertilizing constituents is exchanged for more concentrated feeding stuffs. For instance, the exchange of a ton of corn for a ton of wheat bran will result in a gain of twenty-one pounds of nitrogen, forty-six pounds of phosphoric acid, and twenty-four pounds of potash. With an exchange of milk or potatoes for concentrated feeds the gain is even greater.

Stable manures.— The manure produced by farm animals constitutes one of the most valuable assets that the farmer has at his command for the purpose of keeping up the fertility of his land. The total annual production of manure, both solid and liquid, for each thousand pounds of live weight is about nine tons for the horse, thirteen tons for the cow, fifteen tons for swine, and about five tons each for sheep and poultry. The wide variation in the amount produced by the different classes of animals is due largely to the difference in the amount of water, horse, sheep and poultry manure being comparatively dry while cows and swine produce a wet manure.

Handling manure.— Under the conditions that prevail on most farms much of the value of the manure is lost by failure to

properly store and handle the animal excrements. The three principal sources of loss are: (1) Failure to preserve the liquid manure; (2) leaching by rain; (3) hot fermentation.

The necessity for preserving the liquid as well as the solid manure is apparent from the following table which gives the approximate composition of the solid and liquid excrement from different classes of animals.

PLANT FOOD MATERIALS PER 1000 POUNDS OF EXCREMENT

SOURCE	POUNDS OF ESSENTIAL ELEMENTS		
	Nitrogen	Phosphoric acid	Potash
Horse:			
Solid	5.05	3.50	3.00
Liquid	12.00	0.00	15.00
Cow:			
Solid	3.00	2.50	1.00
Liquid	8.00	0.00	14.00
Swine:			
Solid	6.00	4.50	5.00
Liquid	3.00	1.25	2.00
Sheep:			
Solid	7.50	6.00	3.00
Liquid	14.00	0.50	20.00

From this table it will be seen that for horse, cow, and sheep manure more than two-thirds of the nitrogen is in the liquid manure, and that the potassium is from five to fourteen times more abundant in the liquid than in the solid manure. Practically none of the phosphorus, however, is contained in the liquid excrement. These facts point to the necessity of having

ABSORBING CAPACITY AND MANURIAL VALUE OF BEDDING MATERIALS

MATERIALS	POUNDS OF WATER RETAINED PER 100 LBS. AFTER 24 HRS.	POUNDS IN 100 POUNDS OF AIR-DRY MATERIAL		
		Nitrogen	Phosphorus	Potash
Wheat straw	220	0.5	0.25	0.80
Oat straw	285	0.6	0.30	1.20
Corn stover	350	1.0	0.30	1.40
Muck	450	1.5	0.25	0.30
Dried leaves	200	1.0	0.20	0.35
Pine needles	175	1.0	0.20	0.15
Saw-dust	435	0.2	0.10	0.40
Shavings	375	0.1	0.10	0.30

tight stable floors and to the need for sufficient bedding to absorb all of the liquid manure produced.

Both dry muck and soil are effective in absorbing the liquid and in preserving the valuable parts of the manure, but since they have a tendency to foul the stock and the stable they should be used under a thin layer of fibrous material like straw or shavings.

Manure always suffers appreciable loss if subject to leaching by rain water. For this reason any of the methods of storage that permits rain water to pass through the manure or to displace a corresponding amount of liquid already absorbed, results in serious losses. Small, thin piles are especially wasteful and should be avoided both in the barn-lot and in the field. If manure cannot be taken direct to the field from the stable and spread evenly over the soil it should be stored either in a tight pit or in large compact piles so deep that the rain does not penetrate to the bottom.

Application of manure to the land.—For the general farmer the best practice is to apply the manure to the land as rapidly as it is made, spreading it in a thin, uniform layer and depending upon the absorptive capacity of the soil to reduce the losses to a minimum. Truck farmers and gardeners store their manure in large compost heaps from five to six feet deep and flat or saucer-shaped on the top to absorb the rain and thus keep the pile moist. A pile of this depth has sufficient capacity to absorb any ordinary amount of rainfall.

The place in the rotation where manure can be applied to the best advantage is a difficult question to decide and must be determined by the character of the soil and the requirements of the crops. In general forage and grass crops make a better use of manure than do the small grains. In a rotation of corn, oats, wheat, clover, the manure can usually be applied to best advantage on the clover sod to be plowed down for corn. In mixed farming where grass is let stand for three or four years the use of manure as a top dressing on the new seeding greatly increases not only the grass crops but residue of manure together with the grass sod and stubble has a marked effect upon the grain crops following the grass.

At the Cornell Experiment Station the application of ten tons of manure per acre to grass land for two years in three, increased the average yield of hay two hundred and fifty per cent and the value of the succeeding crops of corn, oats and wheat to the amount of $34.61. At the Ohio Experiment Station the

value of a ton of manure as an average for several rotations over a long period of time has been about three dollars. At the same station eight tons of manure applied on the corn and on the wheat in a five-year rotation has given a gross return of four dollars and sixty-nine cents per ton.

The returns that may be expected from a ton of manure depend upon the condition of the soil, the value of the crop and the quantity of manure used. In general the largest returns per ton of manure will be secured: (1) from soils that are deficient in organic matter; (2) when used on crops of high value per acre; (3) when used in moderate quantities. Within reasonable limits the smaller the application per acre the larger the returns per ton of manure although the total acre value of the crop increase will be less. For example, if one-half of a field is manured at the rate of five tons per acre and the other half at the rate of ten tons, the acre yield from the latter will be much larger than from the former but the increase derived from the ten-ton application will not be twice that received from the lighter application. In general farm practice the use of from five to ten tons of manure per acre on each of two non-legumes in the rotation is about as much as can be used with profit. These light applications can be made most effectively by the use of a manure spreader. By the use of the spreader the labor cost is materially reduced and the same amount of manure can be made to go farther than when spread by hand and a more even distribution is secured.

For most soils the effectiveness of the manure is greatly increased by re-inforcement with acid phosphate or with raw ground phosphate rock at the rate of fifty to sixty pounds of the phosphate for each ton of manure. This material may be used in the stable under the bedding as an absorbent, or it may be mixed with the manure in the storage shed or on the spreader as it is being hauled to the field.

Green manuring crops.—All of the methods, such as tillage, drainage, etc., employed for making plant food materials available tend to decrease the amount of organic matter or humus in the soil, because the conditions that are favorable for making plant food available, also favor the decomposition of the organic matter. The plowing under of green crops to restore the organic matter and thus keeping up the fertility of the soil was advocated by Roman writers more than two thousand years ago and has been practiced by progressive farmers ever since.

Two classes of plants are in common use for green manuring

purposes, (1) those that add nothing except what they get direct from the soil and, (2) those that increase the nitrogen supply. To the first class belong such crops as buckwheat, rye, rape, mustard, etc., and grass sods that are plowed down. Although these crops add no element of plant food to the soil, nevertheless they are beneficial because they gather food from the soil and on their decay leave it in forms suitable for the use of the succeeding crop. To the second class belong the clovers and other legumes that in addition to being humus formers, have the power of extracting nitrogen from the air and upon their decay making this nitrogen available to non-legumes. Of the legumes, the crops most extensively used are red clover, cowpeas and crimson clover.

FIG. 9.—Plowing under a green manuring crop restores the organic matter.

In the East and South crimson clover and vetch are frequently seeded in the fall and serve as a winter cover crop to be plowed down for the benefit of the spring crop. In the Middle West rye is used in the same manner. If these cover crops are allowed to make a rank growth and are turned under late in the spring they may work injury to the succeeding crop by cutting off the moisture supply from the deeper layers of soil.

Commercial fertilizers.—As a rule the manure produced on the farm is not sufficient to maintain fertility and the purchase of plant food materials in the form of commercial fertilizers is necessary to keep up fertility. The constantly growing demand for something that will increase crop production and help to maintain fertility has given rise to a commercial fertilizer industry of gigantic proportions.

Soils and crops differ in their fertilizer requirements.—Nitrogen, phosphoric acid, and potash are the plant food elements most likely to be deficient in soils or most quickly

exhausted by the production and removal of crops. These materials are known as the essential plant food materials or the golden tripod upon which successful farming must rest.

The value of a commercial fertilizer is determined solely by the amount and the form of the nitrogen phosphoric acid and potash which it contains Since the needs of the soil and the requirements of the crops vary, it follows that not all soils or all crops will respond to the use of fertilizers containing these three elements. A sandy soil is usually lacking in all three of the essential plant foods while clay soils contain more of the mineral elements and are especially rich in potash. Black muck soils are rich in organic matter but lacking in the mineral elements, while soils derived from certain geological formations may be rich in phosphorus or potash if these elements are found in abundance in the parent rock.

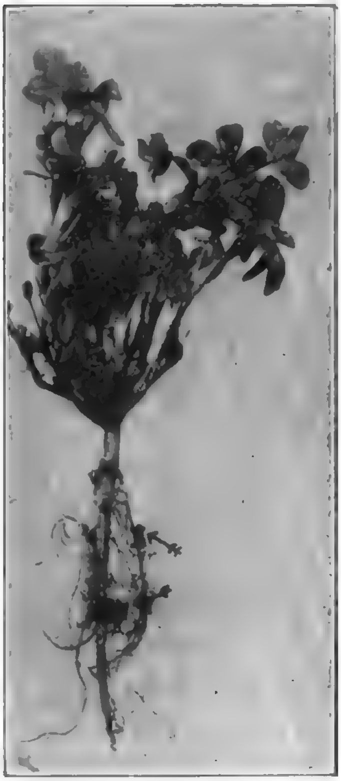

Fig. 10.—Nodules on roots of alfalfa by means of which nitrogen is absorbed from the air.

Plants of the clover family differ from other plants in being able to take up and use the nitrogen of the air, hence they are not dependent upon the soil nitrogen for their growth. On the other hand grass and grain crops are wholly dependent upon the soil nitrogen and must have an abundance during their period of most rapid growth if good crops are to be harvested. This variation in the needs of soils and the requirements of crops makes it necessary that every farmer should know his own particular requirements before he can make an economical use of commercial fertilizers.

Fertilizer materials.—From what has been said it will be understood that any material that supplies one or more of the three essential elements may be used as a commercial fertilizer, but, as a matter of fact, only a few materials are available for use as fertilizers because of the prohibitive price of many of the substances carrying plant food materials. The manufacturers

of commercial fertilizers purchase these basic materials and mix them together in proportions to give the percentages of nitrogen, phosphoric acid and potash required for their particular brands. Some of these basic materials, such as nitrate of soda, or acid phosphate contain only one of the essential elements while others like bone, or tankage, contain two of the essential elements. The materials used in the manufacture of fertilizers are known as carriers.

Nitrogen carriers.—The principal carriers of nitrogen are dried blood, meat, hoof and horn meal, tankage, dried fish, leather meal, nitrate of soda, and sulphate of ammonia.

Dried blood is the blood from slaughterhouses that has been dried rapidly and ground into a fine powder. It contains from six to fourteen per cent of nitrogen, the exact amount depending upon the method of preparation.

Meat, hoof and horn meal are dried animal materials from slaughterhouses and rendering establishments, ground to fine meal. These materials contain from ten to fourteen per cent of nitrogen, that in the meat meal being much more readily available than that in the hoof and horn meal.

Tankage consists of the dried waste materials from slaughterhouses and is quite variable in composition. It derives its value both from the phosphoric acid as well as from the nitrogen which it contains. The nitrogen content varies from four to nine per cent and the phosphoric acid from three to twelve per cent.

Dried fish is derived largely from the menhaden fisheries of the Atlantic coast and from canning factories. The fish are steamed and pressed to remove the oil after which the remains are dried and ground. This product contains from eight to twelve per cent of nitrogen and three to five per cent of phosphoric acid.

Leather meal is made from small scraps of leather that have been ground into a fine powder. Because of its low availability it is not a desirable source of nitrogen, and in some states manufacturers who use leather or hair waste must make a statement of that fact in giving the analysis of the fertilizer.

Nitrate of soda is a substance closely resembling coarse table salt, and since it comes from Chili it is sometimes called Chili saltpeter. It contains fifteen to sixteen per cent of nitrogen and is quickly and completely soluble in water, consequently its nitrogen is readily available to plants.

Sulphate of ammonia is a by-product in the manufacture of gas, animal charcoal and coke. It also resembles common salt

and contains twenty to twenty-three per cent of nitrogen in a readily available form. It should not be used on soils that are deficient in lime.

Market gardeners and others engaged in intensive farming need to make liberal use of nitrogenous commercial fertilizers, but the general farmer will find it much more economical to depend upon clovers, stable manure and green manuring crops to furnish nitrogen, supplementing these sources by the purchase of commercial forms of nitrogen when it can be done with profit.

Potash carriers.— Previous to the war with Germany, practically all of the potash used for fertilizers came from that country in the form of Strassfurt salts. Some of these salts were imported in their crude form, such as kainit, but the great bulk of the material was brought over as either muriate or sulphate of potash, both of which contain about fifty per cent of actual potash in a soluble form. During the war several sources of potash were developed in the United States. The more important domestic supplies come from the brines of old lake beds in some of the western states, from kelp or giant sea-weeds, and from flue dust collected from blast furnaces and cement mills.

Most soils, especially clays, contain much more potash than nitrogen or phosphoric acid but the greater part of this native potash of the soil is very insoluble and not readily available for the use of crop plants. Even clay soils respond to light applications of soluble potash, and for light, sandy soils and muck, potash fertilizers are absolutely necessary for profitable crop yields. Potatoes, tobacco, and root crops are heavy consumers of potash and give generous response to the use of fertilizers high in potash.

Phosphoric acid carriers.— The phosphorus found in fertilizers is derived mainly either from the minerals of certain rocks, or from the bones and the tankage from slaughterhouses.

Mineral phosphates are obtained from extensive phosphate rock deposits found in the Carolinas and in Tennessee and Florida. These rocks contain from eighteen to thirty-two per cent of phosphoric acid and are sometimes marketed as fine ground raw phosphate rock or floats, the material being prepared for fertilizer purposes by grinding the raw rock to a very fine powder without previous treatment. Since this material is not readily soluble it should be used only in connection with an abundant supply of manure or where green manuring crops are being plowed under. The rotting of the manure and the decay of the green manuring crops in the soil produce acids which

attack the fine rock particles and help to liberate the phosphorus. Experience has shown that the raw ground rock can be used with profit when plowed under with green manuring crops like clover or soy beans and that it has a high fertilizing value when mixed with stable manure.

The mineral phosphates are usually found on the market in the form of acid phosphate which is made by treating the raw ground phosphate rock with acid for the purpose of making the phosphorus soluble in water and immediately available for the use of the crop. The better grades of acid phosphates contain from fourteen to sixteen per cent of phosphoric acid.

Bone phosphates.—Most of the bone sold for fertilizer purposes is in the form of a meal that is made by grinding the bones that have previously been treated with steam to remove the fat and a part of the nitrogen compounds. Steamed bone meal contains from one to two per cent of nitrogen and from twenty-eight to thirty per cent of phosphoric acid and is considered to be more valuable than the raw bone meal for fertilizer purposes, because the steamed bone can be much more finely ground and the removal of the fat causes the particles to decay more rapidly in the soil. Tankage, mentioned under nitrogen carriers, is sometimes called bone tankage if it contains a large proportion of bone. Tankage varies greatly in the amount of phosphorus carried, the amount depending upon the quantity of bone present in the waste material.

Phosphorus is present in the soil in much smaller quantities than potash and experience has shown that it is more likely to become exhausted than is the potash. In some sections of the country phosphates are practically the only commercial fertilizer used.

Mixed fertilizers.—In the making of commercial fertilizers the manufacturer mixes two or more of the foregoing carriers in the correct proportions to give the desired percentage composition of nitrogen phosphoric acid and potash. The fertilizer unit is one per cent of a ton, or twenty pounds. A three-ten-four fertilizer is one that contains three units, or sixty pounds of nitrogen or ammonia, ten units, or two hundred pounds of available phosphoric acid, and four units, or eighty pounds of potash. The *trade* or *commercial* value of such a mixture should be determined solely by the number of pounds of plant food materials which it contains. The *agricultural* value of a fertilizer is determined by the extent to which the mixture supplies the needs of the soil and meets the requirements of the crops to

which it is applied, and does not necessarily have any connection with the price or trade value. For example, on a soil already well supplied with nitrogen and potash a ton of acid phosphate costing twenty dollars may have the same or a greater value than the same amount of complete fertilizer costing fifty dollars per ton.

Calculating and comparing trade values.— To calculate the price per unit, the price per ton should be divided by the per cent of plant food contained. Thus, for example, if it is desired to determine what sixteen per cent acid phosphate, selling at twenty-four dollars per ton, is worth per unit, divide twenty-four dollars by sixteen, which gives one dollar and fifty cents as the price per unit. To determine the price of potash in an 0-12-4 fertilizer, selling at thirty-four dollars per ton, first deduct the value of the twelve units of phosphoric acid which, at one dollar and fifty cents, is eighteen dollars. This leaves sixteen dollars as the price of the four units of potash. Dividing sixteen dollars by four, gives four dollars as the price per unit of potash. If, next, it is desired to know the price of nitrogen in a 2-12-4 fertilizer, selling at forty-six dollars per ton, deduct first the value of the twelve units of phosphoric acid and four units of potash, which is thirty-four dollars. This leaves twelve dollars as the price of the two units of nitrogen. Dividing twelve dollars by two, gives six dollars as the price per unit of nitrogen.

Quantity and kind of fertilizer to use.— The quantity of fertilizer used must be related to the value of the crop treated. The higher the acre value of a crop, the larger the quantity of fertilizer that may be used profitably. The season when a crop grows influences the need for fertilizers. Grain and hay crops may usually receive an application of two hundred to four hundred pounds, potatoes six hundred to one thousand pounds, garden and vegetable crops one thousand to two thousand pounds, and fruits five hundred to eight hundred pounds.

Crops that mature seed are usually those most benefited by phosphorus. Crops that make a large vegetative growth in leaves, roots, and flowers, and are used for those parts, are especially benefited by nitrogen. Potassium is most used in stem and root plants; this element gives stiffness to straw, and is especially beneficial to leguminous crops and to root crops.

Plants that start growth in early spring or late fall generally are benefited by the addition of a little available fertilizer, especially nitrogen.

In the absence of knowledge that the soil is well supplied with

A

B

FIG. 11.—The agricultural value of a fertilizer is determined by the extent to which the mixture supplies the needs of the soil. The piles of wheat shown in A and B were grown on the same area of land.

one or more elements in available form, the safest plan is to use a moderate quantity of a complete high-grade fertilizer. The following are some good standard combinations in percentage:

	Nitrogen	Phosphoric acid	Potash
1	4	10	6
2	4	8	10
3	3	11	5
4	2	8	12
5	3	5	15
6	6	8	4

Numbers 1 and 3 constitute good fertilizers for almost any crop on a normal soil. Numbers 2 and 4 are relatively stronger in potash for potatoes, root crops, and legumes. Number 5 is especially suited for muck soil. Number 6 is especially a vegetable fertilizer on normal upland soil in good condition.

Generally, large applications of fertilizers should be thoroughly mixed with the soil rather than placed in the hill or the row. Small applications are more effective when applied in the rows.

Home-mixing of fertilizers.— Commercial fertilizers may be purchased ready-mixed or the materials may be bought and mixed at home. Home-mixing is advisable for the farmer who is in position to study the subject since the purchase of the materials separately enables him to be sure that he is getting only high-grade carriers and, furthermore, he is able to have a slow or a quick acting fertilizer, as the needs of his crop may demand.

The mixing of the materials is comparatively simple. Any tight floor or wagon box may be used and the only tools required are shovels and a screen. The materials are weighed out and spread in layers, the most bulky first, and then thoroughly shoveled over. The mixture is then passed through a sand screen and the lumps broken up with the back of a shovel. When large quantities are to be mixed the use of a small rotary concrete mixer is advised. The mixing should be continued until the whole pile is fine and uniform after which it may be used at once or bagged and stored in a dry place for future use.

The following table gives the information necessary to make mixtures of any desired percentage composition. To make up a three-ten-four mixture using nitrate of soda, acid phosphate

(sixteen per cent), and muriate of potash, it will be necessary to take three times one hundred and thirty-three pounds, or three hundred and ninety-nine pounds, of nitrate of soda; ten times one hundred and twenty-five, or one thousand two hundred and fifty pounds of acid phosphate; and four times forty, or one hundred and sixty pounds of muriate of potash. This will make a total of 1809 pounds, to which can be added one hundred and ninety-one pounds of sand or muck to make the weight up to one ton. In a similar manner any other fertilizer formula may be duplicated by using this table.

QUANTITY OF CARRIERS NECESSARY TO MAKE ONE PER CENT

INGREDIENT	POUNDS NECESSARY TO MAKE ONE PER CENT
Carriers of nitrogen:	
Nitrate of soda	133
Sulphate of ammonia	100
Dried blood	200
Carriers of phosphorus:	
Acid phosphate (14%)	142
Acid phosphate (16%)	125
Carriers of potash:	
Muriate of potash	40
Kelp ash (30%)	66
Nebraska potash (22%)	90

Liming the soil.—On acid soils lime must be applied before the best results can be secured. It must be remembered, however, that lime cannot take the place of fertilizers, nor can fertilizers take the place of lime. The first step in building up fertility is to make sure that the land is well supplied with lime, since without lime it is not possible to grow clovers and other legumes successfully and without clover sod or legume cover crops the nitrogen supply of the soil cannot be economically maintained under average conditions.

One of the easiest methods for testing the soil for acidity and the need for lime is the litmus paper test. A sample of soil is moistened with distilled or rain water and a strip of either blue or neutral litmus paper is pressed into the moist sample. If after a few minutes the paper turns red the soil is acid and in need of lime. Since clover and alfalfa are very easily injured by acid conditions, a good stand of either of these legumes is a good indication that lime is not needed.

Kind of lime to use.—When a ton of pure limestone or oyster

shell is burned, about one thousand one hundred and twenty pounds of stone or burned lime is produced. When this is slaked it takes up water until it weighs about one thousand four hundred and eighty pounds and is known as hydrated lime. When this is exposed to the air for some time it goes back to the carbonate or limestone form and to the original weight. Since all lime quickly reverts in the soil, the form in which it is applied is of importance only in regard to its concentration and the fineness of the particles. Raw ground limestone or oyster shell have only about half the strength of burned lime and two-thirds that of the hydrated lime.

Fig. 12.—Twelve bushels of wheat per acre with fertilizer alone; twenty bushels with lime and fertilizer. The first step in building up fertility is to make sure that the soil is supplied with lime.

The value of any form of lime depends upon the total percentage of calcium and magnesium oxide contained. Ground limestone or shell should contain about fifty per cent of total oxide; hydrated lime about seventy per cent; and lump or burned lime above ninety per cent. To compare the prices on several kinds of lime divide the cost per ton of each, delivered, by its percentage of oxide. This gives the cost per unit or per twenty pounds of oxide or actual lime.

Applying lime.—Crops that grow moderately well on sour soil are potatoes, tomatoes, buckwheat, berries, carrots, watermelons and red-top grass. Practically all other crops are benefited by lime, but the most responsive crops are alfalfa, clover,

soy beans, corn, oats, wheat, cabbage, cauliflower, celery, beets, cucumbers, lettuce, onions, spinach and sweet potatoes.

Since lime is gradually carried downward in the soil, it should be applied to the plowed surface and worked in as the seed-bed is prepared. Truck farmers sometimes plow under burned lime and manure together in order to hasten the action of the manure, but in general farm practice the manure should be plowed down before the lime is applied, otherwise much of the value of the manure will be lost.

Have your county agricultural agent test the soil from your fields. He can tell you not only whether lime is needed, but also how much you should use of the different forms to supply the lime requirements of your soil.

CHAPTER II

LAND DRAINAGE

By Elmer O. Fippin, B.S.A.[1]

Evidences of the need for drainage.—Large areas of farm land are too wet for the best growth of crops. Land is too wet whenever within the zone of soil in which the roots of crops develop, namely, about three feet of the surface, free water would stand in an excavation. Drainage does not remove useful water from the soil. It removes the injurious surplus water from the soil. Remember that the roots of the usual type of farm crops — corn, wheat, clover, fruit trees and that type of plants — will not live in a soil saturated with stagnant water for more than two or three days, and even that period of submergence weakens the general vitality of the plant.

This line of observation should suggest to the reader that it is not necessary that water stand on the surface of the soil or even in the plow furrow in order that the soil be poorly drained. Roots of most crops penetrate two, three and even four and five feet deep if given an opportunity, and therefore the creation of perfect conditions for crop growth requires that the possibilities of standing water in the soil within a depth of at least two feet should be avoided by artificial drainage if the natural drainage is inadequate for that purpose.

Other indications of a wet soil, in addition to that soft, mirey character, familiar to all, are severe "heaving" when it freezes; curled leaves of crops on such areas in dry periods, and areas of weeds such as planton and other plants best able to withstand such conditions. In addition, the subsoil that is poorly drained has a mottled color and otherwise shows by its appearance that it is inclined to be too wet. The more intensive the type of crop production the more important it is that good drainage should be insured.

Why land is wet.—Land may be wet from a number of causes. Throughout the eastern half of the United States, and, in fact, wherever the annual rainfall exceeds thirty-five inches, there is more water than crops require or the soil can retain in the film

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form, from which crop roots are chiefly supplied. In fact, in such regions from one-fifth to more than one-half of the rainfall ultimately drains into the streams.

On any soil of a dense structure, such as clay, and on loamy and lighter soils having a compact sub strata, and also where the soil may be loose and porous, but shallow, due to the near approach of bed rock, this surplus water is held too long in the root zone near the surface of the soil. Such land needs drainage. This condition may, and frequently does, occur on quite steep slopes. A hillside is no guarantee that good soil drainage exists.

Another type of wet land is of the springy sort. For one reason or another, the general underground flow of this surplus water is brought to the surface by some impervious strata and appears as springs of greater or less persistence and value. No fixed rules for their occurrence can be laid down beyond that already stated. The observations and experience of the average individual will indicate to him that they may occur on a broad flat as well as on a hillside or in the more common position at the foot of a slope.

Then there is the wet land due to the overflow of streams at periods of high water and the land that is wet because it is so near the level of the surface of the water in some adjacent stream, pond, lake or even the ocean; for there are thousands of acres of tidal marsh land. Wet land may be divided into two general types, namely (a) swamp or marsh land and (b) moderately or intermittently wet land.

Extent of wet land.—The total area of wet farm land in the United States is very large. Swamp and marsh land aggregates something like twelve thousand square miles, or upwards of seventy-five million acres. The very much larger area of wet land falls in the second or intermittently wet group. This area is included in farms and is more or less under cultivation. East of the eastern line of Kansas the area of farm land now being cultivated that is giving inadequate returns because of poor drainage aggregates several times the area of swamp and marsh land. Every farmer should understand that his first problem is to drain this wet land on which he is expending money for labor, materials and interest to grow poor crops. This is the really big farm drainage problem in any part of the world having a rainfall similar to the eastern half of the United States. The intermittent wetness of such land is even more injurious than is constant wetness because it results in wider extremes of moisture supply to the crop.

Types of drainage.—There are two general classes of drainage: (1) Open drains; and (2) under drains. Any channel or opening which permits the removal of the excess water in a soil is a drain. It may be an open ditch or canal so small as that made with a shovel plow, or it may be as large as a river. It may be an underground channel maintained by poles or brush or straw or stone or boards in the form of a box, or in tight clay it may be an unwalled opening made by a mold plow. On the other hand, it may be an opening nicely graded and carefully arranged in a system of more or less parallel channels lined with short sections of clay or cement pipe or drain tile, and finally, where there is a rather thin, impervious strata on which water is held and below which is a porous strata, such as gravel, sand or a porous rock, drainage may be provided by means of a well dug, drilled or formed by an explosive through the impervious layer down to the porous strata. This latter is verticle drainage applicable to only a very limited area of land.

One's choice of these different methods of drainage must be guided by the conditions of soil and rainfall, the area of land, volume of water, grades and other features with which he has to deal in a particular case. It is usually unwise to attempt to follow any set rules for drainage. One should study the particular conditions at hand, consider the underlying principles involved and proceed accordingly. A great many conditions of wet land can be worked out by the average farmer with such facilities as he may have at hand.

Beneficial effects of draining.—But why, it may be asked, is proper drainage of the soil so fundamental to good soil management? First of all, remember that practically all of the crops ordinarily cultivated are accustomed to grow in soil in which is distributed sufficient free air to meet the needs of the roots for their proper functioning. Roughly, this amount is represented by a well-drained soil in good tilth. As any farmer knows, the tilth or physical heart of the soil is linked up with its moisture condition. Therefore, in enumerating the benefits of drainage, we may start with its effects on the physical condition or tilth of the soil. (1) Reasonable drainage is the first requisite to the maintenance of that fine friable granular condition of soil known as good tilth. Wet soils, if clayey, are usually lumpy when dry. Otherwise, they are very compact and impervious. (2) Good tilth results in a larger pore space in which to store available moisture and necessary air for the roots. It means better and deeper ventilation. This results (3) in deeper root penetration.

As a consequence of all these changes (4) the soil actually carries more water available to crops and drouth periods are better withstood than on poorly drained land, especially intermittently wet upland. One way to locate wet land is to observe the wet spots where the leaves of crops are curled in dry weather. (5) They are less subject to the damaging effect of freezing and thawing, especially on winter crops. (6) All the myriads of beneficial bacteria in the soil and necessary to its fertility are favored by good drainage and the conditions incident to it. This includes the organisms that bring about the formation of humus and the fixation of nitrogen and its changes into available forms. (7) Drained soil warms earlier in the spring and maintains a higher average temperature than wet soil. (8) Less time is lost after a rain and in getting crops planted in the spring. The farm equipment and labor may be more efficiently managed. (9) All the various materials in the soil used by the plant as food are rendered more available by the conditions that have been enumerated. The need for fertilizers may be reduced and the efficiency of that applied will be increased.

Wet land is usually the potentially best land on the farm and it usually responds with big crops when this condition is corrected.

Open drains.—Very little need be said to the average farmer concerning open drains. The smaller sizes suitable for the small farm are simple trenches with such slope to the wall as to prevent serious covering of the banks. Usually they may be fairly steep. For large channels a one-half slope is common. This is a slope formed by a one-foot vertical rise for a foot of horizontal distance on the bank. For smaller channels a steeper slope, namely, one foot vertical to one-half foot horizontal, or even less, is used. Bends should begin and end gradually like the curve in a railroad. Right-angle turns should be avoided. Keep the channel clean and in good form.

Under the best conditions, open ditches are very objectionable. (1) They obstruct and waste the land surface. (2) They are very likely to be filled up with weeds and sediment. (3) They harbor weeds. (4) Most serious of all, the smaller ditches, especially those so frequently made with a shovel or turning plow and which are only six to ten inches deep, scarcely remove surface water and do not accomplish the purposes of real internal soil drainage. At the best, this type of open ditch is very inefficient. On the other hand, due to the need for temporary results, or on very low, flat land, or where a very large

volume of water must be handled, the open ditch may be the only available means of drainage.

Under drains.—Farm drainage should generally be synonymous with tile drainage. Covered drains of any kind free the surface of obstruction and are likely to be more permanent and less expensive to maintain than open ditches. Tile drains, where needed, and in which good clay or cement tiles are used, are both a satisfaction and the very best kind of a business investment. The earlier substitutes, such as poles, brush and stone drains, now have very little place in competition with tile for drainage purposes. They are nearly, if not quite, as expensive to construct, and much less permanent, especially on low grades.

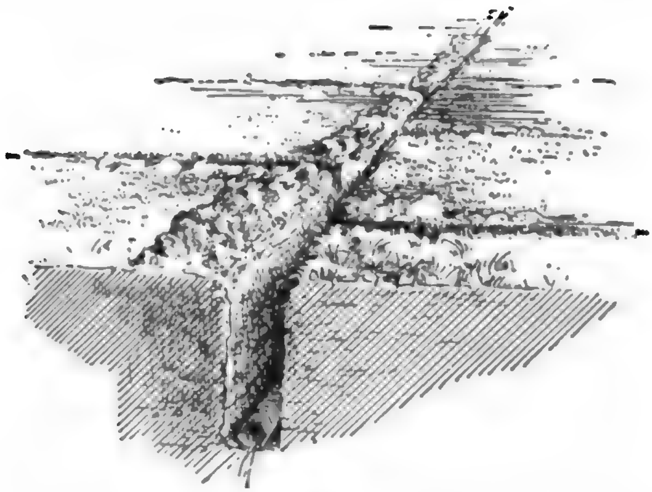

Fig. 13.—View of system of underdrains placed at regular intervals. Adapted to land wet throughout and on which intensive cropping is to be practiced.—*New York State College of Agriculture.*

In a few cases, namely, where the bottom is very soft or where they are deeply placed and where the soil has a very pronounced tendency to silting the drain, wooden box drains may be the better material. This is especially true in draining seepy, irrigated lands. But for the humid land farmer, tile drains are usually the most satisfactory method of drainage.

Quality of tile.—A good tile has walls that are nearly or quite impervious to water, that are straight and fairly square at the ends, smooth inside and without flaws due to lime nodules or pebbles in the clay. They should give a sharp, clear ring when struck with a hammer. They may be either hexagonal or round. A single flat side is an undesirable form, since it increases the

difficulty of forming a good joint. Horseshoe tile are even more undesirable for the same reason.

Impervious walls are especially important in any cold region where the tile is likely to freeze in the ground. The degree of porosity that may be found in so-called, soft tile does not add to their efficiency as drains, since water enters the drain through the joints between the tile. On the other hand, the walls of a tile may be so porous as to take up as much as twenty per cent of water in the minute capillary pores, and when this freezes the wall of the tile is ruptured, and if the process is repeated enough times the tile will crumble to pieces. Even one or two such weak pieces in a line of drains may jeopardize the system without any corresponding benefit.

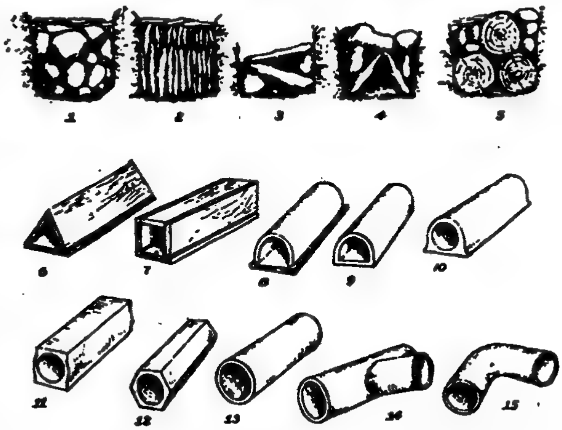

FIG. 14.—The most common types of drainage tile and other materials used for land drainage:

1. Cobblestones with smaller pieces of stone on top.
2. Flat stones placed face to face and parallel to line of ditch.

3 and 4. Throated drains constructed of flat stones used in different ways.

5. Pole drain.
6. Triangular box drain.
7. Square box drain. Note construction for admission of water along lower edge.
8. Horseshoe tile laid on a board.
9. Horseshoe tile, bottom attached.
10. Single sole tile with round opening.
11. Double sole tile.
12. Hexagonal tile.
13. Round tile.
14. Y-shaped junction piece.
15. Elbow piece.

—*New York State College of Agriculture.*

The choice between good clay tile and concrete tile turns primarily on this point of the porosity of the walls. Unless very carefully made, the concrete tile is likely to be the more porous. If concrete tile are used, there should be added to the cement about ten per cent of its volume of hydrated lime, which will make the walls more impervious.

Joints.—The construction of the joints is a critical part of the system. Imperfect form of the ends of the tile will usually make it easy to leave an opening one-sixteenth to as much as one-quarter of an inch wide. The larger opening should be on the under side. The more the soil in contact with the tile has

that soft quicksand quality, the more important it is to have good close joints. It is a good plan in all cases to cover the upper half to two-thirds the joint with a strip of tar paper or burlap about three inches wide. Water should enter the tile on the lower side of the joint. In tight clay or in other soil inclined to hardpan properties, a fairly open joint with this covering on the top will greatly facilitate drainage.

Suitable grades for drains.—The low grade or slope at which a tile drain will operate efficiently is one of the big advantages it has over open ditches where the smaller volumes of water are to be handled. If the slope is straight a tile will operate on as small a grade as one or two inches per hundred feet. Naturally this minimum depends on the size of the tile, the number of turns, and the inclination to accumulate sediment, all of which interfere with the use of low grade. Eight inches to one foot of fall in one hundred feet of length is a more satisfactory grade upon which to operate and simplifies the details of forming the trench to receive the tile. Where very large grades are used there is danger that the tile may be washed out by water flowing along the outside of the tile in flood periods unless the soil is worked down very closely around the tile.

Arrangement of tile.—The arrangement and size of tile are questions specially related to the particular land to be drained. First of all, if there is any doubt about the direction and extent of grades available, a survey adequate to the situation should be made. It may involve the use of a very accurate leveling instrument with determination of the form of the land surface and position of important points and lines from which to construct a map, or it may involve only a few rough levels such as may be secured from the flow or the level of water, or the use of the less accurate type of levels such as

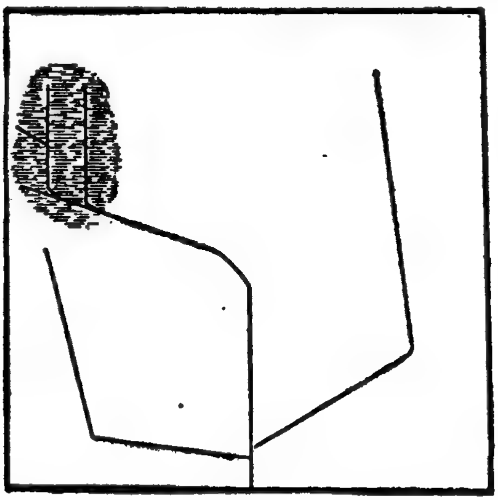

FIG. 15.—Sketch showing a "random" drainage system and the location of tile used in draining forty acres of land in Scott County, Ill. Only part of this land needed drainage.—*U. S. Dept. of Agriculture.*

may be devised from a carpenter's level and a straight edged board.

A little assistance and advice from someone experienced in land drainage to determine the layout of the drain and the size of the tile may be the means of saving the entire investment with the benefit that should occur. These details are fundamental to the system and one dare not slight them.

Construction for particular conditions.— Having established the grades available on any particular area, certain types of soil condition may be considered with reference to the arrangement and depth of drains. A series of drains either in parallel lines or in lines having irregular arrangement may be joined together in a system having a single outlet just as the rills and creeks unite to form the larger rivers. There are two general types of arrangement namely, (1) the natural or irregular system in which the drains are placed in hollows or at strategic places to catch the drainage water, but do not cover the entire area at regular intervals, (2) the regular or parallel system in which lines of tile at regular intervals are arranged parallel, in so far as the uniformity of the slope will permit.

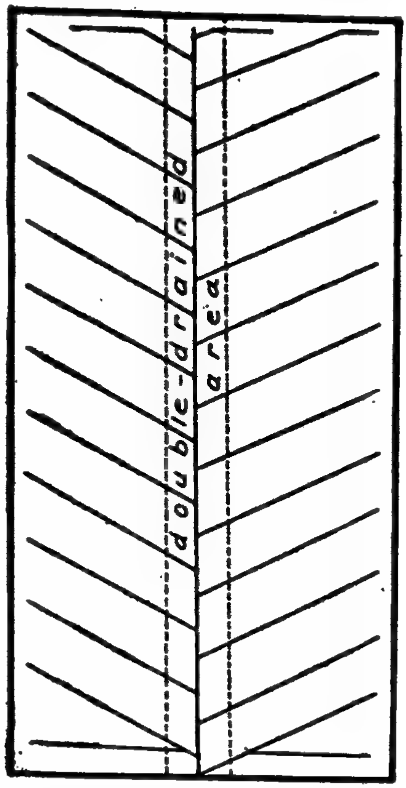

FIG. 16.—Sketch showing a system of drainage in which the cost of installing is increased by too much double draining.—*U. S. Dept. of Agriculture.*

On flat land of tight, clayey texture, drains are likely to be needed at fairly regular intervals of from four to five rods for mixed general farming, down to two rods or less for the more intensive special cropping, such as vegetable gardening. Then, too, they should not be too deep. Two to two and a half feet is sufficient for laterals. If the subsoil has pronounced hardpan properties an even less depth may be advisable up to eighteen inches. This is a very exceptional case. The point is that

in such soil the water mostly moves over the surface or through the upper soil and will thereby reach a shallow drain more readily than a deep one.

When a tight soil underlies a porous soil within three or four feet, the best position in which to place the tile is at the junction of these two materials. A shallow trough in the hard material in which to lay the tile should be formed if the tile would be less than three feet from the surface of the land.

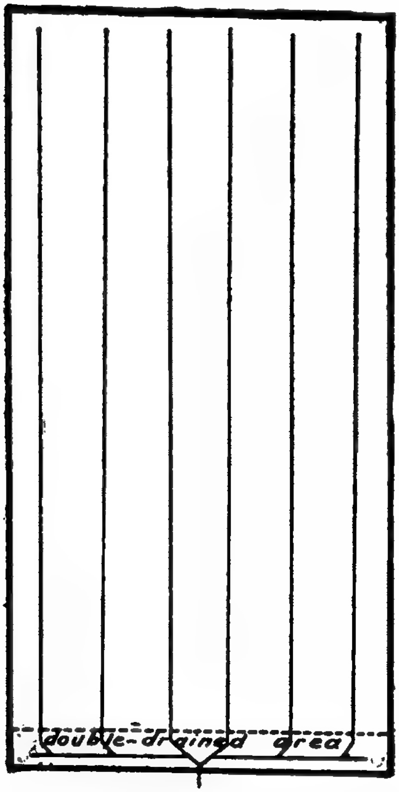

FIG. 17.—Sketch showing a system of drainage by which the area of double-drained land is reduced to a minimum.—*U. S. Dept. of Agriculture.*

Wherever the subsoil has tough clay properties, it should be dried before it is returned to the trench. A hardpan quality of soil should not be placed on the tile if a porous top soil is reasonably available.

Loose sandy land, if wet, results from some pocket or obstruction in the subsoil. The drains should be placed at a medium depth of three to four feet, since the water table rises in the soil until it reaches the level of the drain. Often a rim of tough soil will be encountered which may be primarily responsible for the wetness of a large area. Drains may be from five to ten rods apart, depending on the nature of the soil.

In muck soil drains should be from three to four feet deep and from fifty to one hundred feet apart. Tile placed shallow may be uncovered by the shrinkage and decay of such soil.

On slopes and hillsides that are uniformly wet, nearly the same arrangement should be followed as on flat land. It is usually best to run the drains up and down the slope.

Where local springy places and wet hollows occur, they should be reached by the most direct course. Sometimes this condition is combined with general wetness, and the two sets of principles

then need to be united, namely, a regular system coupled with spurs and side lines to reach the wetter spots.

Springy lines on the side of a slope or at its foot may often be intercepted by a drain across the slope near the upper side of the wet area and cutting fairly deep or down to the impervious layer that is forcing the water to the surface. Sometimes two or more such intercepting lines are necessary, and on a springy hillside diagonal drains may be best.

Muck soil areas, especially small pockets, should generally have a drain along the border at the foot of the slope. It should be added that for muck soils the first drains should usually be open drains until the muck has settled and the nature of its subsoil and the sources of water have been determined.

Pronounced springs should be tapped by the most direct route and if they spread over a considerable area spur drains on one or both sides should be arranged like a funnel to intercept the flow. These spurs should cut fairly deep.

Two or three feet is a good average depth for drains.

Plant roots and under drains.—The penetration of the roots of trees or other plants into tile drains is not determined by the depth of the drain so much as by whether water flows continually in the drain. In dry periods the roots are likely to be led toward the tile where it carries a continual flow of water. Certain types of trees, such as the elm, poplar, willow and even the apple, may be especially troublesome in this way. Tight joints formed with cement in the neighborhood of such plants is the only available protection. Ordinarily, plant roots do not much interfere with field drains. When the land is uniformly drained, roots do not enter the tile.

Size of tile.—The size of drains should be determined by several factors. The more important of these are (a) the rainfall, which will determine the amount of surplus water in the soil, (b) the slope of the drain, (c) the porosity of the soil and the manner in which the rains occur, whether as ordinary showers and rain periods only or very heavy downpours, (d) the occurrence of springs and surface flow which would increase the volume of water in the soil over that due to rainfall on the local area, (e) the texture of the soil in relation to the grade. Soils having silty or quicksand (very fine sand) properties require the larger tile.

The capacity of a tile to carry water depends mainly on two things: These are its diameter and the slope at which it is laid. The capacity varies with the square of the diameter rather

than with the diameter directly. An eight-inch tile will carry as much water as two six-inch tile on the same grade.

Ordinarily, for large areas the outlet drain is of such size as to discharge from the entire area of land tributary to the system anywhere from one-quarter to as much as three-quarters of an inch of water in twenty-four hours, depending on rainfall, surface slope and the occurrence of springs. The following table will give some idea of the area of land that may be drained by different sizes of tile laid on different grades:

Number of Acres from Which One-fourth Inch of Water will be Removed in Twenty-four Hours by Outlet Tile Drains of Different Diameters and Different Lengths with Different Grades

Diameter of tile in inches	Grade in inches per 100 feet, 666									
	1"		2"		3"		4"		5"	
	Length of drain in feet									
	1,000	2,000	1,000	2,000	1,000	2,000	1,000	2,000	1,000	2,000
	Acres of land drained by different sizes of tile									
5	19.1	15.7	22.1	19.4	25.1	22.7	32.0	30.3	37.7	36.3
6	29.9	24.8	34.8	30.5	39.6	35.9	30.5	47.8	59.4	57.3
7	44.1	36.4	31.1	44.8	58.0	52.8	74.0	70.1	87.1	84.1
8	61.4	50.7	71.2	62.6	80.9	73.6	103.3	98.0	121.4	117.3
9	82.2	68.1	95.3	83.8	108.4	89.6	138.1	131.3	162.6	157.1
10	106.7	88.5	123.9	108.9	140.6	128.1	179.2	170.5	211.1	204.4

For small field laterals on grades of one foot or more per hundred within the limits of length of one thousand feet, three-inch tile may be used. The general inclination is away from the smaller sizes, especially those below three inch. For more flat grades and especially in fine sandy, silty and muck soils four and five-inch tile should be the minimum size.

For the submains and mains the tile should be correspondingly larger according to the area of land served. For these larger systems an experienced engineer is necessary to decide on these important details.

The outlet.—The outlet should be the first thing located on a drainage system and the last part safeguarded. The outlet tile drain should be properly buttressed to prevent washing and caving, and the end protected by a grating or gate against the entrance of small animals.

Junctions of tile.—The junction of two lines of tile should be in the form of a Y with the lateral pointing down the slope and with the center of the two lines of tile on the same level, especially for the smaller sizes of mains.

Filters and silt wells.—Surface intakes, filter basins and silt wells are details that are sometimes very important. At best, surface intakes are dangerous and in all cases much care is required in the use of screens and settling basins so as to admit only water free from much sediment or rubbish.

A rock filter to admit surface water should have fine gravel, small stones or straw around the tile to hold back the flow of water and collect the sediment.

Silt wells, which are wells in the line of the drain and several feet deeper, in which sediment is collected, require a large exercise of judgment in their location and construction.

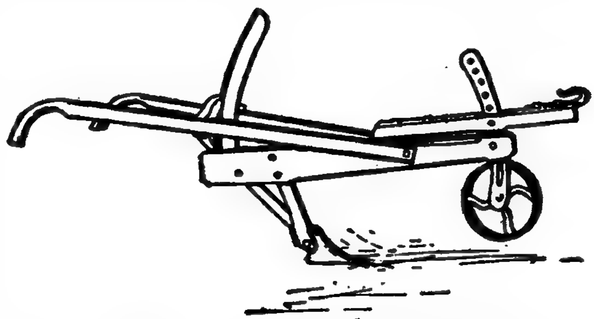

FIG. 18.—Ditching plow used for loosening the earth in the bottom of the ditch. A number of patterns of plows of this type are on the market. The handles and the hitch are usually adjustable, in order to suit the depth of the trench. The plow is drawn by two or more horses, attached to a long evener so that they travel on either side of the trench.—*New York State College of Agriculture.*

Drainage tools and machinery.—The tools for constructing the ordinary farm drain especially for tile may be divided into three groups:

(1) Where the work is done by hand they include various types of narrow, long-pointed spades, round-pointed, long-handled shovel, grading scoop, pick and perhaps a tile hook for placing tile in a narrow deep ditch. No more earth is moved than necessary and consequently the trench is not more than twelve to fifteen inches wide.

(2) The second group of tools embrace: Horsepower excavating plows that range from a blacksmith-made tool for loosening the earth to big-wheeled plows drawn by six or more horses, which both loosen the earth and more or less completely elevate it out of the ditch.

(3) The third group of tools includes the engine power excavator; some of these excavators cut the trench to full depth and

accurately grade at one operation, and place the excavated earth in a convenient pile at one side of the trench, where it may be returned readily after the tile are placed in position.

The contract system.—As a result of the shortage in labor in recent years, drainage is coming more and more to a contract basis, under which arrangement the tools in groups two and three, especially the latter, together with skilled operators, are employed. In fact, the art of drainage is becoming more and more an expert contracting proposition, and rightly so, as we believe this is the better method of handling large drainage operations.

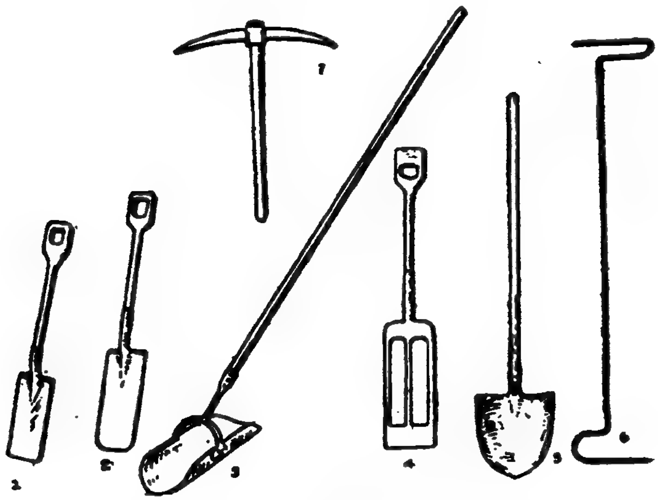

FIG. 19.—Tools for ditching.

1 and 2. Ditching spades for removing the major part of the earth from the ditch.
3. Grading scoop used to finish the bottom of the ditch and the grade.
4. Skeleton spade adapted for use in very plastic soil.
5. Shovel for removing crumbs and loose earth.
6. Hook used to place tile in deep, narrow trenches.
7. Pick for loosening stone and hard earth.

—*New York State College of Agriculture.*

Drainage a business proposition.—Land drainage is a business proposition just like a roof on a factory or a drain in the cellar. It makes possible the more complete use of the potential resources of the farm and increases the product. If it is wisely installed, it is a first class business investment and though it is costly, like every other type of construction, it should be regarded as an investment and not merely a short time investment, but a long time investment that, if well made, will continue to return dividends by the decade and the century, rather

than for only a few years. Experienced farmers very generally agree that drainage of wet land under cultivation is one of the best investments that can be made and the lower the price of crops the more important it is that their production be made as economical as possible by that improvement in the efficiency of production which drainage makes possible.

Nearly a century ago John Johnston, he of Scottish birth, laid crockery in his land near Geneva, New York, while his neighbors scoffed. Those drains are still operating in good form, and that farm is producing crops far above the average for that section of the state. The missionary message from those first tile laid in America is still sounding through the country and that message is calling more and more farmers to improve the drainage of their land as a business proposition.

CHAPTER III

CORN, WHEAT, OATS, BARLEY, RYE, AND ROTATION OF SMALL GRAINS

By R. F. Wiggans, Ph.D.[1]

CORN

Corn is by far the most important crop in the United States. Not only the acreage and production but also the value of this crop is far greater than that of wheat, oats, barley, and rye combined.

The world's corn crop.— The world's yearly corn crop averaged 3,867,247,000 bushels for the period 1910–1917. Three-fourths of this is produced in North America, while the United States produces ninety-three per cent of the North American crop, as the following tables show, the data of which is abstracted from the United States Department Year Books.

Percentage of World's Corn Produced by Continents (1910–1914)

North America	75.7
Europe	16.3
South America	5.1
Africa	2.6
Australia	.3

Percentage of World's Corn Produced by Principal Corn Producing Countries (1910–1914)

United States	70.2
Argentina	6.3
Mexico	4.4
Roumania	2.8
Italy	2.7

Production within the United States.— Seven adjacent states in the Mississippi Valley constitute what is known as the corn belt. Within the borders of these states is produced more than one-half of the corn crop. Regardless of the fact that corn production is concentrated in Illinois, Iowa, Missouri, Nebraska, Indiana, Kansas, Texas, and Ohio, every state in the United

[1] College of Agriculture, Cornell University.

States produces some corn, although the acreage may be small. The following table indicates the relative importance of corn in the different divisions of the United States:

DIVISION	PERCENTAGE OF TOTAL UNITED STATES PRODUCTION
North Atlantic	3.3
South Atlantic	8.2
North Central	66.2
South Central	21.9
Far West	.4

Origin of corn.—Corn was probably first brought under cultivation in the plateaus of Central America. From there, it probably spreads in both directions. By the time Columbus discovered America, corn was under common cultivation throughout both continents. From America it soon spreads to Europe where it has become of considerable importance, as shown by the foregoing tables.

So far as the biological origin is concerned, it is uncertain what wild plant is the ancestor of corn. There are two wild plants, gama grass and teosinte, which are closely related to corn, and there is good evidence that corn may have originated from one or the other or some closely related form.

Classification of corn.—There are six principal types of corn in cultivation, most of which have a large number of varieties. These types are: Pop corn, flint corn, dent corn, soft corn, sweet corn, pod corn.

This classification is based very largely on the character of the kernel. The first four are distinguished from each other by the character of the starch within the kernel. Pop corn has a very hard and flinty kernel; flint corn is nearly as hard and flinty but much larger and usually contains a small amount of soft starch in the center; dent corn is not more than one-half hard and flinty while the rest of the kernel is soft starch, the larger part of which occurs at the top of the kernel which when dry causes the denting; soft corn is made up entirely of soft starch with a kernel shaped very much like that of flint; the sweet corns differ from the others by possessing a sugary instead of a starchy endosperm, the sugar failing to change to starch as it does in the other types; the pod corns may be any of the above types, whose individual kernels are surrounded by small scales or pods.

Relation of climate to the production of corn.—Under favorable conditions of climate and soil, corn is capable of very high yields. Yields of two hundred to two hundred and fifty-five bushels per acre have been recorded where heavy applications of manure and fertilizer were made and where the soil and climatic factors were favorable. Regardless of the ability of corn to yield, the average for the United States is about twenty-six bushels per acre.

The best climate for corn production is one with abundant sunshine, warm days and nights, and plenty of rainfall. Regions with favorable temperatures and rainfall with frequent cloudy days often cause a retarded growth and reduced yield; likewise, regions with warm days and favorable sunshine and rainfall conditions but with cool nights are not ideal for corn production. Rainfall is also a limiting factor in a large portion of the United States, especially in regions of less than twenty inches. A heavy crop of corn requires an enormous amount of water. In the production of one bushel of corn from eighteen to twenty tons of water is taken up by the roots of the plant and lost by transpiration from the leaves. The time when an abundant supply of water is required is during the three months of the growing season, June, July and August. If other conditions are favorable, a rainfall of twelve to fourteen inches during this period, if well distributed, will insure a good crop.

Adaptation.—Corn originated in a warm, humid climate with a long growing season, but has become adapted to regions varying widely in these climatic factors. Corn varieties vary in the time required for maturity from ninety to two hundred days; they likewise vary in their ability to yield in dry climates, at high elevations, etc. Although corn is grown to a greater or less extent in this wide range of climatic conditions, the greatest production is restricted to a definite area with a mean summer temperature of seventy degrees F. to eighty degrees F., a mean night temperature of about fifty-eight degrees, a season of one hundred and forty days or more without frost and an annual summer rainfall of at least eight inches with a total of twenty-five to fifty inches.

Relation of soils to the production of corn.— The best corn soils are deep, warm, dark-colored loams or silt loams with a large amount of organic matter and available nitrogen. These soils are most often found in the river bottoms of the Mississippi River basin. However, corn production is not limited to such soils or else there would be only a small acreage in the United

States. As in the case of climatic factors corn has become adapted to a wide range of soils, varying in texture from very heavy clays to light sands, and in fertility from soils rich in both organic matter and mineral nutrients to very poor soils. Much can be done in improving poor soil conditions by proper

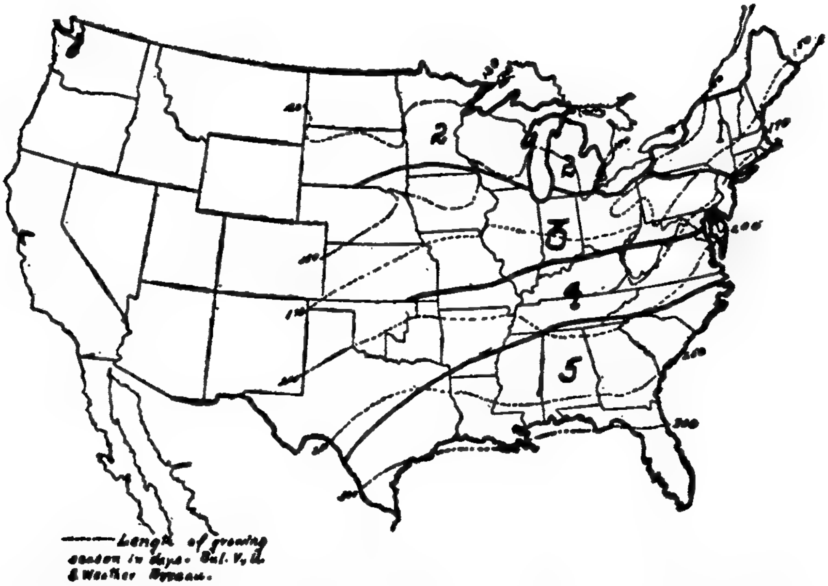

FIG. 20.—Regions of corn production according to types grown (after Montgomery).

crop rotations, application of fertilizers and manures and proper drainage, as will be explained later.

Varieties to grow.—In corn as in all other cereals there is a very large number of varieties which cause confusion. Many varieties are known under different names, while the same name is often applied to different varieties. This confusion makes it very uncertain in selecting varieties to grow. The best that can be done at present to aid in the choice of varieties is to give a few well established varieties that have proven satisfactory in the different regions. Many local conditions, such as elevation and locally developed varieties, etc., enter into particular cases. The following varieties are given for the regions as suggested by the accompanying chart.

SECTION	GRAIN		SILAGE
	Flints	Dents	
1	Eight-rowed Yellow King Philip Hall's Gold Nugget	Pride-of-the-North Northwestern Dent Cornell No. 11	Luce's Favorite Early strains of Leaming Hall's Gold Nugget Hickory King
2	King Philip Smut Nose Eight-rowed Yellow	Pride-of-the-North Minnesota No. 13 Wisconsin No. 7 Early Huron	Luce's Favorite Early strains of Leaming Hall's Gold Nugget Hickory King
3		Leaming Reid's Yellow Dent Silvermine Boone County White Johnson Co. White St. Charles White	Same as for grain
4		Boone County White Leaming St. Charles White Hickory King	Same as for grain
5		Eureka Mosby Cocke's Prolific Boone County White St. Charles White	Same as for grain

Some of the well-established varieties may be grouped as follows, according to maturity:

GROUP	VARIETY	DAYS TO MATURE
Early Flints	New York State Flint Dakota Flint King Philip Smut Nose Longfellow Sanford White	90–110
Early Dents	Early Huron Minnesota No. 23 White Cap Bloody Butcher Silver King	100–110

GROUP	VARIETY	DAYS TO MATURE
Late Flints	Hall's Gold Nugget Dibble's Mammoth	110–120
Medium Dents	Northwestern Dent Cornell No. 11 Pride-of-the-North White Cap Minnesota No. 13 Wisconsin No. 7 Calico Bailey Dent	115–125
Semi-Dents	Luce's Favorite Hickory King	120–125 130–140
Late Dents	Leaming Boone County White Johnson County White Sweepstakes St. Charles White Silvermine Reid's Yellow Dent	120–140
Very late Dents	Eureka Wood's Virginian Mosby Cocke's Prolific Virginia Horsetooth	130–150

This list is by no means complete but will serve as a guide in placing other varieties which may be of local importance.

Improvement of corn.—Each corn growing region of the country has varieties which are particularly adapted to that region. For example, the prolific varieties which are tall and very late, with more than one ear to the stalk are characteristic of the Gulf States, while in New England rather short, early, single eared varieties are grown. These differences have come about very largely through selection by farmers, consciously or unconsciously, and by the natural adjustment of the corn plant to its environment. Due to this fact a farmer in choosing a variety should always investigate the local sorts first. After the local varieties have been thoroughly tested there are three general methods open for improvement in corn: (1) introduction of varieties from outside sources; (2) selection within local or introduced varieties; (3) crossing.

Introduction of varieties from outside sources should not be generally practiced because (1) the already confused condition

existing in regard to varieties would be increased; (2) varieties grown under certain climatic conditions usually require considerable time to become adapted to a different set of conditions; and (3) it is a rather expensive operation. If this method of improvement is undertaken by the farmer the following precautions should be observed: (1) bring in varieties similar to varieties that are known to do well in the region; (2) bring in varieties that have been grown under similar climatic and soil conditions; (3) begin in a small way, not trusting the entire crop to the new variety; and (4) compare thoroughly with established varieties before passing final judgment.

Selection within the variety is the method whereby some of our best varieties have been produced and a large amount of improvement within the existing varieties has been accomplished. A good illustration of the development of a variety by selection is Reid's Yellow Dent, which is the result of nearly fifty years' selection for an ideal. The work was begun by James Reid in 1846. To be sure it is not desirable or worth while for every grower to attempt to produce a new variety, but it is worth while for a large number to attempt improvement both in uniformity and in yield of the existing varieties.

The lack of uniformity in varieties is readily seen either in the field or after the corn is harvested. Just as much variation in ability to yield exists between individual ears as exists between any readily observable character such as the shape of kernels. Herein lies a great opportunity for selection and improvement.

The methods used in selection within a variety are: (1) Crib selection; (2) field selection; (3) pedigree selection. The old and time-honored method of crib selection, where the best looking ears are used for seed, has not generally produced very favorable results because the ability of an ear to produce high yielding plants cannot be told by external appearances. This method is, however, better than taking crib run. Field selection is a marked improvement over the crib selection method. In this case plants are selected that produce the desired characters (yield, type of ear, position of ear, etc.) under average conditions. Plants which have a distinct advantage by being adjacent to missing hills or stalks, or by exceptionally fertile spots, etc., should be avoided. It is best to select these plants while still growing, but in case this cannot be done, the selection may take place when the corn is harvested. This corn is then well cured and stored for planting. This method can be

employed with good results by practically all farmers within their own fields.

The third method, known as pedigree selection, is begun by first selecting ears in the field as above, but instead of shelling all the ears together they are planted separately the following year in an ear-to-row test, where a portion of the grain from each ear is planted in a separate row, harvested and weighed separately, thus ascertaining the high yielding rows. The remnants of the ears from which the seed came for the high yielding rows are then planted the second year in a separate block for increase. The seed from the increase block is used for the general field the following year. This process may be continued time and again with good results. The difficulty with this method is that it requires considerable time and care, more time and care than the average producer cares to take. It is suited only to those that are especially interested and are willing to make the sacrifice of time and take the necessary precautions.

Seed storage and testing.—It has already been pointed out that crib selection of corn is not advisable, neither is the crib a good place for storage of seed corn. After careful field selection seed corn must be properly stored to insure the best results in germination. Proper treatment consists chiefly of quick drying of both cob and kernel, which have a moisture content of twenty-five to thirty per cent at harvest. This is best done in a warm dry room with a large amount of ventilation. Artificial heat may be employed successfully but is not necessary; ventilation is, however, very necessary. The drying should be nearly complete before freezing weather, since freezing injures the vitality of the corn when damp. Well dried corn, corn with twelve per cent or less water, is uninjured even by hard freezes.

The value of seed testing has been well proven the past few years, especially following years with early frost and consequently large amounts of immature seed. Even after very favorable corn growing seasons there is always a considerable acreage planted with poor seed, which results in a partial failure of the crop. On account of the ease with which the test can be made, it should never be neglected completely with the one excuse of not having time. The Iowa Experiment Station has shown that it takes less than one and one-half minutes per ear to test the germination of corn when several hundred ears are tested. It is sometimes permissible if one is fairly sure of excellent seed to run a general test on the whole lot of seed corn by

germinating two or three kernels from each of a hundred ears selected at random. If they test very high a further test is unnecessary, but if they test ninety per cent or less a detailed test is very necessary. This test may be carried on by (1) the rag doll method, (2) by germinating box of sand or sawdust, or (3) any convenient method whereby a sufficient amount of moisture and heat may be applied to cause good germination.

The rag-doll method is where kernels are placed on a strip of cotton flannel or any other absorbent cloth about six inches wide and thirty-six inches long and rolled up, tied, and dipped into water about body temperature for eight to ten hours, then removed and placed in a warm moist condition to germinate. When the seeds have sprouted well the counts can be made and the poor ears discarded. This method has not always proven satisfactory because conditions have not been kept favorable for germination.

The sawdust or sand box method is probably as good as any other. In this case a box three inches to six inches deep is filled, preferably with sand, marked off by strings placed across it in both directions two and one-half or three inches apart. The spaces thus formed are named (C4, D8, etc.) by lettering the spaces on one side of the box and numbering them on the other. Ears are then numbered to correspond with the squares and six kernels taken from various parts of each ear and placed in the sand to a depth of one inch, well watered and placed in a warm room for germination. The sand should be kept moist until the test is complete. By this method the strength as well as the percentage of germination can be determined and thus both weak and dead ears discarded. Seed corn testing should always be done during slack time in winter.

In preparing corn for planting it is usually advisable to remove the small kernels at the tip and the irregular kernels at the butt of the ears, not because they will produce less but because the planter will drop more evenly when seed of uniform size are used, consequently a more uniform stand will result.

Rotations for maintaining yields of corn.—The term "crop rotation" is usually understood to-day to mean a succession of crops on a given area, including grass, grain and a cultivated crop, so that fertility is more or less maintained as well as good tilth of the soil. In the beginning of agriculture in this country, crop rotation was unnecessary because of an over supply of virgin soil. But as this surplus was taken up the maintaining of fertility became more important. It was soon recognized

that continuous cropping of a soil to one crop depleted the fertility of the soil. This is very definitely shown by experimental results for eighteen years from the Ohio Station as given in the following table:

CROP	FIRST FIVE YEARS	LAST FIVE YEARS
Corn	26 bu.	8 bu.
Oats	28 bu.	15 bu.
Wheat	10 bu.	6 bu.

Very similar results have been secured at various experiment stations. Continuous cropping of land causes a depletion of organic matter, nitrogen and mineral elements, and finally a poor physical condition of the soil. It is due to these facts chiefly that rotations have been developed.

The advantages of a crop rotation are listed below:

1. Helps maintain organic matter and nitrogen content of the soil.
2. Keeps soil in good physical condition.
3. Helps control weed, insect and fungus pests.
4. Helps to make available more mineral matter.
5. Distributes man, horse and machine labor so as to make it more efficient.
6. Lessens risk of complete failure.

The effect of crop rotation on yield of corn may be illustrated by data from the Illinois Experiment Station.

SYSTEM	AVERAGE YIELD OF CORN OVER A PERIOD OF 29 YEARS	ORIGINAL PRODUCTIVENESS OF LAND	PERCENTAGE DECREASE
Corn, continuously	27 bu.	70 bu.	61.4
Corn, oats	46 bu.	70 bu.	34.3
Corn, oats, clover	58 bu.	70 bu.	17.1

Although there has been considerable decrease in all cases, the decrease has been very much greater under continuous cropping than where the crops are rotated. The effect of a legume in the rotation is also very apparent. Likewise the data show conclusively that rotations alone where the crops are all removed will not maintain fertility. Fertility can be maintained where mineral fertilizers are employed in connection with a rotation including legumes and green manures.

Rotations for corn production.—In general the essentials to be included in a good rotation are: (1) A cultivated crop; (2) one or more legumes; (3) a heavy sod forming grass; (4) deep rooted crops; (5) opportunities for catch crops to be used as green manures. With these things in mind every producer must choose a rotation that best answers his own conditions. Some of the standard rotations, including corn, are:

FIRST YEAR	SECOND YEAR	THIRD YEAR	FOURTH YEAR
(1) Corn................	Oats	Wheat	Clover
(2) Corn................	Oats	Clover	
(3) Corn................	Wheat	Clover	
(4) Corn................	Beans	Wheat	Clover
(5) Corn................	Oats	Cotton	
(6) Corn................	Cow peas, oats	Clover	
(7) Corn................	Soy beans	Wheat	Clover
(8) Corn................	Wheat	Alfalfa (several years)	

Many variations of these rotations might be given, especially to include catch crops such as crimson clover, or rye and vetch.

Barnyard manure.—It was stated under crop rotation that fertility, and consequently crop yield, cannot be maintained by crop rotations alone, but by the addition of legumes, green manures or barnyard manure and mineral fertilizers fertility can be maintained and even increased. The value of organic matter cannot be over emphasized in maintaining fertility, neither can the value of barnyard manure as a source of organic matter. Results from various experiment stations, based on fifteen to twenty-five years' results, show an average value of manure based on the increase in yield of corn alone in the rotation to be about $2.50 per ton, and it must be understood that the total value is by no means exhausted by the one corn crop. In fact, it is just as well, and probably better, to apply the manure to the grass and have the residual effect for the corn. By this means the yield of grass is increased and a heavier sod produced to turn under for the corn with a greater total return per ton of manure for the whole rotation.

Mineral fertilizers.—Mineral fertilizers ordinarily do not pay large returns when used alone on corn as only a part of it is recovered by the crop. It will pay, however, when used in connection with a rotation where manure and legumes are employed. Under these conditions it is best to apply the mineral fertilizers to the grain crops, the manure to the sod and plow a heavy sod

under for the corn. Of the three mineral elements (nitrogen, phosphorus and potash) often deficient in the soil, phosphorus is most often lacking. Phosphorus may be applied at times at the rate of one hundred and fifty to three hundred pounds per acre directly to the corn land with a good profit, but nitrogen and potash have not usually given a profit. Although producing considerable gains in yield, the gains have been only sufficient in most cases to pay for the added cost. The value of manure and phosphate to corn in a corn-wheat-clover rotation can be shown by the following results secured at the Ohio Experiment Station:

TREATMENT	POUNDS PER ACRE	AVERAGE YIELD OF CORN PER ACRE	
		1897–1905	1906–1913
None		37	33
Manure	8 tons	57	64
Manure Acid Phosphate	8 tons 320 lbs.	62	73

Limes.—The value of lime in connection with certain legumes has become well established, but its value when used with corn has received less attention, and justly so, because (1) the success of the crop by no means depends on an application of lime, and (2) such large percentage gains have not been secured as with other crops. However, lime has generally been found to increase yield of corn, whether used alone or in connection with manure and fertilizers, sufficient to more than pay for the application and in some cases the cost per bushel gain has been as low as ten cents. When this is considered, together with the fact that lime continues to have a beneficial effect on soils for several years, it is certainly worth applying, especially on heavy soils and soils deficient in lime.

CULTURAL METHODS

Preparation of the seed bed.—The object of seed bed preparation in any case is to produce the most favorable conditions for plant growth. In the case of corn, the seed bed should be well plowed, pulverized and freed from weeds. The freeing of land of weeds before planting is very essential because it cannot only be done more cheaply but also much better before the corn is planted than at any later date. Plowing in gen-

eral is necessary in order to: (1) Increase the water-absorbing capacity of the soil; (2) prevent evaporation; (3) warm up the soil; (4) increase circulation of air in the soil; (5) increase the available plant food elements. Plowing may be done either in the fall or in the spring largely according to conditions on the farm. In general, however, it is much better to plow sods or land receiving a heavy application of manure in the fall in order that the organic matter may become partially decayed. On the other hand, very heavy soils run together so badly during the winter that spring plowing is almost necessary. In case land is plowed in the spring it should be plowed as early as possible in order to get the maximum benefits.

Deep plowing is usually advisable for corn. Some exceptions to this general rule occur: (1) If land has been plowed shallow for a series of years it is not advisable to plow deep the first year, but the depth of plowing should be gradually increased each year until a depth of eight or nine inches is reached; (2) if the land is to be plowed late in the spring, it should not be plowed so deep that the seed bed cannot be firmed. Very deep plowing (fifteen to twenty inches) has not proved generally beneficial.

The objects of the preparation of the seed bed immediately before planting are (1) to pulverize the surface soil; (2) to compact the seed bed if spring plowed (fall plowed land becoming well compacted due to rains and successive freezes and thaws), and (3) to kill all weeds that have started development. It is sometimes advisable to disk fall plowed land early in the season and again at time of planting in order to destroy more weeds.

Planting.—Corn is planted one and one-half to two and one-half inches deep according to type of soil. It may be planted (1) on the surface, (2) in shallow furrows made either with a single shovel plow or with furrow opener attachments to the corn planter, or (3) in lister furrows. The corn may be planted either by hand, with a drill, or with a two-row planter. Most of the corn planted on the surface or in light furrows is checked, that is, rowed both ways, while the listed corn is usually drilled. There is no particular advantage in yield of checked over drilled corn as long as all other conditions are similar. The check method, however, permits of plowing both ways which makes cultivation much easier. On the other hand, if the corn is to be cut with a corn binder or used for silage the drilled method has the advantage.

The practice of listing for corn is not to be recommended in the eastern United States unless on very light soils. It is of doubtful advantage even in the corn belt. It is, however, a quick way to get corn in the ground and may permit of a little cleaner cultivation than surface drilling, since more soil can be thrown to the corn.

The rate of planting of corn is by no means uniform, as it is influenced by (1) region, (2) variety, (3) purpose for which it is grown. The following table shows the usual rates of planting in the different regions of the United States:

	DISTANCE APART WHEN CHECKED		NUMBER OF PLANTS PER HILL		DISTANCE APART WHEN DRILLED		
	Rows	Hills in rows	Grain	Silage	Rows	Plants in rows: Grain	Plants in rows: Silage
Gulf states	4′–5′	4′	2	2–3	4′–5′	24″	18″–24″
Middle states	3′ 8″–3′ 6″	3′ 8″–3′ 6″	2–3	3	3′ 8″–3′ 6″	12″–16″	12″–16″
Northern states	3′ 6″–3′ 0″	3′ 6″–3′ 0″	3–4	4–5	3′ 6″–3′ 0″	10″–12″	7″–12″

The time of planting corn should largely be governed by the time when the soil and climatic conditions are favorable for the growth of the corn plant. This time varies from the southern to the northern states as follows:

TIME OF PLANTING CORN[1]

REGION	BEGINNING	GENERAL	ENDING	PLANTING PERIOD (days)
Gulf states	March 15	April 15	May 10	55
Central states (Va. to Kan.)	April 15	May 1	May 25	40
Northern states (N. Y. to Minn.)	May 10	May 20	June 1	20

Cultivation of corn is a universal practice, having become so because it is necessary for successful production. There are two chief reasons for cultivation: (1) To conserve moisture, and (2) to destroy weeds. In a humid region (1) is of little consequence, but in time of drought or in dry regions it is important during the first period of growth before root system has become well established. After the root system is well

[1] U. S. Department of Agriculture. Year Book, 1910.

developed little or no moisture is conserved by cultivation. Then the all important reason for cultivation is the destruction of weeds which when permitted to grow cause a decrease in both grain and stover by (1) using available plant food nutrients, (2) using water, (3) shading the corn plants, and (4) increasing the carbon dioxide content of the soil. Any tool which will destroy weeds, leave the surface fairly level and well pulverized, not injure the corn plants, and stir only the surface few inches, is suitable for corn cultivation.

The depth of cultivation is an important consideration in corn production. As a rule it is advisable to cultivate just as shallow as possible in order to destroy the weeds. Deep cultivation destroys feeding roots which come very close to the surface of the soil. In heavy soils the roots are as close as one inch of the surface but as the soils become lighter the roots are a little deeper. Cultivation to a depth of four inches in any case is sure to cause root injury. The number of cultivations depends largely on the weeds to be killed. If the field is fairly clean late cultivations have not given increased yields. Seldom have more than four cultivations proven beneficial if the weeds have been kept under control.

Harvesting of corn.— Various methods are employed in harvesting corn:

1. Harvesting of ears only.
2. Harvesting of entire plant.
3. Stripping leaves while green and harvesting ears when mature.
4. Topping of plant above the ear while green and harvesting ears when mature.
5. "Hogging down," where hogs are allowed to harvest the corn.

The first-named practice is the one employed generally in the Corn Belt where the corn is grown extensively and where coarse fodder is not needed to so great an extent. Usually cattle, sheep, or horses are turned into the stalk fields after the ears are removed. The second method is employed in all dairy regions where the entire plant is harvested either for fodder or for silage. Here the corn is cut by hand, by means of sleds, or with corn binders. If for fodder, the corn is shocked in the field for curing and husked and fed later. If for silage, the corn is immediately run through a silage cutter and into the silo. The third method has been generally employed in the south but is going out of practice on account of the high price of labor. The fourth

method has been employed in the New England States where fodder was desired and where it is thought to hasten the maturity of the ears. The fifth method is coming into use more generally with the increased cost of harvesting the crop. When practiced hogs should be turned into small areas at a time until they have cleaned it up then into another similar area, etc. These areas can easily be fenced as the wire can be tied to the stalks at frequent intervals thus eliminating the need for posts. The hogs make little effort to escape as long as the corn lasts.

The time to harvest corn is at or near full maturity either when the ear alone or when both ear and stover are desired because dry weight increases until the plant is fully mature. This is well shown by the following data from the Michigan Experiment Station.[2]

STAGE OF MATURITY	GREEN WEIGHT PER ACRE IN TONS	DRY WEIGHT PER ACRE IN LBS.	PERCENTAGE			PERCENTAGE OF DRY MATTER
			Leaves	Stalks	Ears	
Tasseled	10.6	3,670	..	..	..	17.3
Milk	12.7	5,320	36	34	29	20.9
Glazed	12.9	7,110	30	25	44	27.5
Mature	11.5	8,020	21	32	46	34.8

From a study of the table it is readily seen why it is advantageous to harvest near the time of maturity. If the corn is to be used for silage other considerations come in which require a little earlier harvest. If not harvested before mature, water must be added to silage when silo is filled; leaves and tassels drop off easily when handling; and the silage does not pack well. Early harvest is also necessary in many cases to avoid frost injury. In this connection it might be said that in regions with short growing seasons it is usually advantageous to grow a variety for silage that will not completely mature but will reach the glazing stage in most seasons. This is advisable because more food nutrients as well as green matter can be secured by growing such a variety to the glazed stage than by growing an earlier variety to maturity. Of course this practice necessitates purchasing seed from an outside source each year.

The loss in weight of ear corn in storage is from five to twenty-five per cent during the first year, due largely to loss of water. The loss in dry weight of either fodder or silage during a similar period is about twenty per cent.

[2] United States Department of Agriculture, Farmers' Bulletin 97.

Uses of corn may be considered under three heads: (1) For animal food; (2) for human food; (3) for miscellaneous purposes. Animal food is the chief use of corn, as ninety per cent or more of the crop is disposed of in this way and it is due to this use that both the animal industry and the great production of corn have developed together in the Middle West. Corn is used as human food in the forms of: (1) Roasting ears; (2) corn meal for mush and bread; (3) pop corn; (4) cereal food; (5) starch. For roasting ears and for canning, sweet corns are best suited. The miscellaneous uses are: (1) Production of alcohol from the grain; (2) production of paper, mattresses, and door mats from the stalks and husks.

Common disease and insect pests of corn.— Corn is less injured by disease and insect pests than any other of our important crops. It is especially free from attacks of all kinds of fungi and bacteria but under certain conditions considerable injury may be done by corn smut and certain ear rots. The combined injuries from diseases seldom reaches one per cent. As these diseases live over as spores on the infected ears, the best control method is to gather and burn all diseased stalks and ears.

The most injurious insects are: (1) Cutworms; (2) grubworms; (3) wire worms; (4) corn-root worms; (5) ear worms; and (6) migratory insects (chinch bug, army worm, and grasshoppers). The first three insects are more abundant after sod and may be controlled to a large extent by exposing the larvæ to freezing by late fall plowing. The corn-root worm is bad only where corn is grown on the same field several years in succession, and can therefore be controlled by crop rotation. The corn ear worm damages the corn ears in the silk stage or later, not only destroying grain but making easy the access of fungus diseases. The greatest damage is probably to sweet corn in the roasting-ear stage, producing unmarketable corn. The migratory insects are not often very damaging to corn, but as in the case of other crops, much damage is done in seasons very favorable for their development. The control methods for these insects will be given under disease and insect pests of small grains.

WHEAT

Wheat, although fourth in importance in the United States, is by far the leading crop of the world. It is the most important food stuff of the leading peoples of the world, has served as a

foundation to agricultural progress, and is now the foundation for our great system of international commerce.

The world's wheat crop.— The world's yearly wheat crop averaged 3,634,000,000 bushels for the period 1907–1916, 734,000,000 bushels, or 20.2 per cent of which was produced by the United States during the same period.

The percentage of the world's crops and to some extent the world's distribution of wheat is given in the following tables:

PERCENTAGE OF WORLD'S CROP BY CONTINENTS, 1914–1916

CONTINENT	AVERAGE PERCENTAGE
North America	30
South America	5
Europe	45
Asia	15
Africa	2
Australia	3

PERCENTAGE OF WORLD'S CROP OF THE LEADING COUNTRIES, 1914–1916

COUNTRY	AVERAGE PERCENTAGE OF WORLD'S PRODUCTION	AVERAGE YIELD PER ACRE
United States	22.4	15.3
Russia	16.3	10.5
India	8.8	....
Canada	6.6	....
Austria-Hungary	4.9	18.1
Argentina	4.0	....
Germany	3.5	29.1

The average yield per acre varies from ten to thirty bushels. Russia has the smallest yield per acre while Germany has the highest. The United States has an average yield of a little over fifteen bushels for the past five years.

Within the United States the five leading wheat-producing states are Kansas, North Dakota, Minnesota, Nebraska, and South Dakota. These five states produce forty to forty-five per cent of the entire wheat crop of the United States and nearly ten per cent of the world's crop. The average yield per acre within these states is ten and five-tenths to eighteen and five-tenths bushels. North Dakota has the lowest average yield and Nebraska has the highest.

Origin of wheat.— The origin of wheat is unknown, since its cultivation precedes all history. De Candolle states: "Very

ancient Egyptian monuments, older than the invasion of the shepherds, and the Hebrew Scriptures show this cultivation already established." Evidence points toward Western Asia as the probable home of the original wild plant from which wheat has been developed.

Range of wheat.— Wheat in some of its forms is now grown throughout the world in all kinds of environments, having a wider range than any other cultivated crop except barley. It is grown in practically all civilized countries, from the hottest to the coldest, and at practically all elevations where civilized man lives.

Classification of wheat.—Wheat, like corn, is made up of a large number of varieties which can be divided into a few rather distinct groups. These groups cannot be based on texture of kernel, as was the case with corn, because of the variation in this character within the same variety when grown under different conditions. But the basis of the grouping is found in the variation of structural characters such as the shape of head, character of the glumes or chaff, adherence of chaff to kernel, etc. The eight groups commonly used in separating wheats are:

1. Common wheat.
2. Club wheat.
3. Poulard wheat.
4. Durum wheat.
5. Polish wheat.
6. Einkorn.
7. Spelt.
8. Emmer.

The first group includes most of the wheats cultivated in this country, the characters of which are well known. The second group is made up largely of soft wheats grown on the Pacific coast but is distinguished from common wheat by a short head which is dub-shaped and a short stiff straw. These two groups make up the bread wheats of the world. Groups three, four, and five are distinguished from all other wheats by having a pithy stem and unusually long kernels. Poulard is distinguished by branched heads; durum by long, light amber, very hard kernels; and Polish by very large, thin chaff. These wheats are used largely for the manufacture of macaroni, etc. Einkorn, spelt and emmer are distinguished from other wheats by retaining the chaff when threshed. Einkorn has only one grain in each segment of the head while spelt and emmer have two grains. Spelt possesses a long, very lax head, while emmer has a rather

short, very compact head. A great deal of the emmer now on the market is sold under the name spelt. These three wheats are of little importance in this country but are grown in some poor, dry soils, and are used for stock food.

Regional types of wheat.— The United States can be divided into regions according to the types of wheat grown. The accompanying diagram map illustrates these regions. Some of the varieties extensively grown in each of these regions are given below:

SOFT WHITE WINTER	SEMI-HARD SPRING
Dawson's Golden Chaff Gold Coin Early Red Clawson	Marquis Fife Preston
RED WINTER WHEAT (Semi-hard)	SEMI-HARD SPRING
Fulcaster Fultz Poole Red Wave Nigger Red Rock	Mediterranean Lancaster Dawson's Golden Chaff Farmer's Friend Gypsy Rudy
SOFT RED WHEAT	SEMI-HARD SPRING
Fultz Currell Prolific Harvest King	Fulcaster Leap Prolific Early May
HARD WINTER WHEAT	SEMI-HARD SPRING
Turkey Karkov Malakov	Kanred Fultz Harvest Queen
HARD SPRING WHEAT	SEMI-HARD SPRING
Marquis Minnesota No. 163 Fife Preston	Bluestems
IRRIGATED WHEATS	SEMI-HARD SPRING
Gold Coin Alberta Red Club Wheats	

PACIFIC COAST SOFT WHEATS	SEMI-HARD SPRING
California Club Gold Coin Little Club Bobs Early Baart	Sonora Australian White

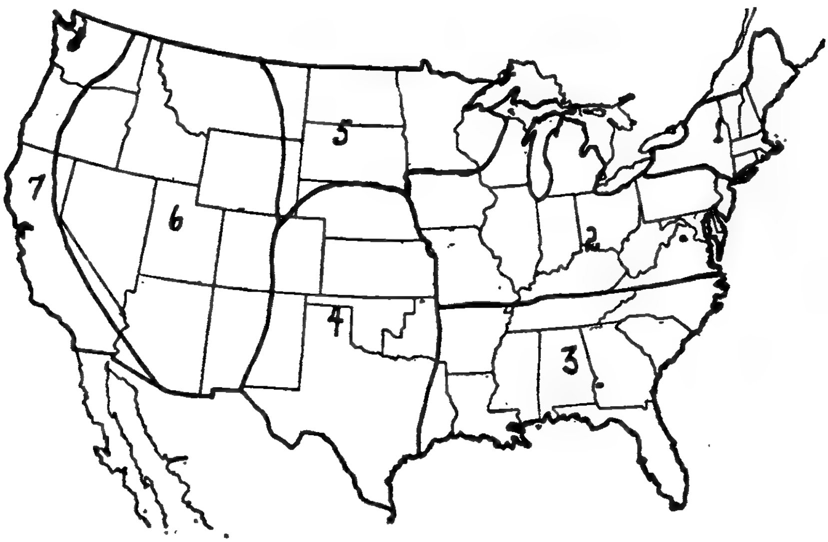

Fig. 21.—Wheat regions of the United States.

These varieties are not always the best varieties to grow in these regions but are the varieties most widely grown at present, which is a more or less reliable guide as to what is best. Likewise the regions overlap each other to a great extent. However, the rather distinct regions indicate the great influence of environment on the type of wheat. For example, the soft wheats are grown in humid regions of the eastern and southern states; the semihard wheats in the region east of the Mississippi river with less rainfall than the above condition; the hard wheats in the region west of the Missouri river to the semi-arid region. Thus the hardness of wheat is generally related closely to humidity and rainfall.

Choice of variety for any region is very important because next to growing wheat better is to grow better wheat. The best variety is difficult and in some cases impossible to find, but if

the desirable qualities of a good variety are kept in mind, the choice of a variety will be much simplified. The desirable qualities in good varieties of wheat are: (1) High yield, (2) stiff straw, (3) early maturity, (4) rust resistance, (5) high gluten content.

Choice of variety for any region is very important because small grain production are quite simple. The chief principles involved are: (1) Fertile soil; (2) elimination of weeds; (3) compact, finely pulverized seed bed; (4) conservation of moisture in some cases.

The kind of soil best suited for the production of wheat is proven by the areas of long-continued wheat culture. Such areas are mostly on silt or clay loam soils which are not as high in humus as the best corn soils but which have an abundance of available plant food. Very little wheat is grown on sandy soils, because the yield is too small for profit. However, soil has less influence than climate on wheat production.

Wheat is a delicate feeder requiring a well-compacted seed bed which permits of a better root development, less drying out, better contact with sub-soil, and less winter killing. In preparing such a seed bed early plowing (one to two months before seeding) has proven considerably better than plowing just before seeding. Likewise deep plowing (six to seven inches) has proven better than shallow plowing (three to four inches) where the plowing is done some time before seeding. Before seeding the land should be freed of the new growth of weeds, fairly well-pulverized on the surface and well-compacted beneath.

Rate of planting wheat.—The rate of planting may vary from six to ten pecks per acre without any material difference in the yield. On the average the extra bushel of seed will just about increase the yield one bushel. This wide range in the rate of planting is permitted because the wheat plant stools or tillers abundantly under favorable conditions. Thus when seeded thinly, the number of tillers per plant is greater than when seeded thickly, resulting in about the same number of heads at harvest time. Rich land can stand a thinner rate of planting than poor land because tillering is more abundant under the more favorable conditions of growth.

Time of seeding wheat depends on the locality. It is usually advisable to sow six weeks to two months before the soil freezes in order to permit of sufficient growth to withstand the winter. This general rule would mean the middle of September in New York and later the farther south the seeding is done. Later

seeding is sometimes necessary in order to escape the Hessian fly.

Method of seeding.— There are two general methods of seeding the small grains on prepared seed beds, namely, broadcast and drilling. The results of accurately conducted experiments all show an advantage of two and five-tenths to three and five-tenths bushels per acre for the drill method. This advantage is due to (1) more uniform stand as a result of better germination since all seed are covered to the proper depth and more even distribution; (2) less winter killing because the crowns are better protected. Drilling has the added advantage of giving clover or grass when seeded with the grain a better chance for development.

Mineral fertilizers for wheat.— The fertilization of land for wheat is becoming more and more important as the natural fertility is reduced. Wheat is a more delicate feeder than either oats or corn and thus requires a supply of available plant food. Generally phosphorus is the element most needed for wheat and good returns are secured by applications of one hundred and fifty to two hundred and fifty pounds per acre of acid phosphate. Likewise potash and nitrogen are often beneficial, but where good rotations are followed, including legumes, little nitrogen is necessary for wheat. Where a complete fertilizer is used, two hundred and fifty to four hundred pounds per acre of a three-eight-five, four-ten-five, or some other fertilizer of similar composition will give profitable returns. Any commercial fertilizer for wheat is applied at or near the time of seeding unless nitrate of soda is added. In this case it should be broadcast as a top dressing in the spring after growth has begun. Manure had better be added to grass or the sod before plowing for corn than as a fertilizer for wheat.

Harvesting wheat.— Wheat should be cut when mature but not long before as the grain reaches its maximum dry weight when well ripened. The common method to-day is to harvest with a grain binder, but the harvest may be done with a self-rake reaper or with a cradle and bound by hand. After the grain is bound it is advisable to shock in loose, small shocks for drying. It may then be stacked in the field or stored in the barn for future threshing or may be threshed direct from the field if the weather is very favorable. This last method, however, will usually result in considerable loss in the eastern United States.

Market grades for wheat.— The farmer is often disappointed when marketing his wheat to find that it grades quite low, which

means a corresponding reduction in price. Up until recently every market had its own grades and it was difficult for the producer to become acquainted with them. This condition is now partly eliminated by official grades, made and adopted by the United States Department of Agriculture, Bureau of Markets. The official grades and requirements for Soft Red Winter Wheat are as follows:

Grade No.	Minimum test wt. per bushel	Maximum limits						
		Moisture	Damaged kernels		Foreign material other than dockage		Wheats of other classes	
	Red Winter		Total	Heat damage	Total	Matter other than cereal grains	Total	Durum
	Lbs.	%	%	%	%	%	%	%
1........	60	13.5	2	0.1	1	0.5	5	2
2........	58	14.0	4	0.2	2	1.0	10	3
3........	56	14.5	7	0.5	3	2.0	10	10
4........	54	15.5	10	1.0	5	3.0	10	10
5........	51	15.5	15	3.0	7	5.0	10	10
Sample..	..	....	..	...	..	...	..	..

The same requirements hold true for common white, white club, and hard red wheats. Slight variations occur in the grade and requirements of hard red spring durum.

Uses of wheat.—Wheat is used chiefly in the manufacture of flour for human consumption, either as bread or macaroni, spaghetti, etc. The by-products from the manufacture of flour, including bran, shorts and middlings, which amount to twenty-six per cent of the whole, are used for animal food. Special uses of wheat are (1) stock food, particularly poultry; (2) hay, especially on the Pacific Coast; and (3) breakfast foods, such as puffed wheat. The straw is used for bedding animals, as roughage in winter, and for the making of paper.

OATS

The oat crop stands next to wheat or fifth in importance in the United States, but as a world crop, wheat is first and oats fourth. This relationship, together with the rank of other crops, is shown in the following table taken from the United States Department of Agriculture Year Books:

AVERAGE OF YEARS, 1910–1914

CROP	WORLD'S PRODUCTION IN MILLIONS OF BUSHELS	UNITED STATES PRODUCTION IN MILLIONS OF BUSHELS	UNITED STATES FARM VALUE IN MILLIONS OF DOLLARS
Potatoes	5,369	361	213
Corn	3,867	2,732	1,577
Wheat	3,735	728	630
Oats	4,266	1,158	443
Rice	1,880	24	21
Rye	1,754	38	28
Barley	1,453	186	111
Hay	.....	66[3]	812
Cotton	.....	14,250[4]	764

In total production of oats the United States is the leading country, with Russia a fairly close second, followed by Germany, Canada, France and Austria-Hungary in the order named. Within the United States the important production is limited to eight adjacent states; Iowa, Illinois, Minnesota, Nebraska, Wisconsin, North Dakota, Ohio and Indiana, in the order named. This order varies slightly from year to year.

The states mentioned above produce about sixty per cent of all the oats produced in the United States. The average yield per acre in this group of states for the period 1906–1915 was thirty-eight bushels, while the average for the United States for the same period was thirty-nine bushels.

Origin of oats.— Like wheat, the history of oats is not known definitely, although its cultivation does not date as far back as that of wheat. Oats did not become important until about the Christian Era. Considerable evidence points to two wild forms which are still in existence as the ancestors of our cultivated oats. It is thought that Red Texas, with various selections made from it, King, and Burt, have originated from one form, while from the other the remaining varieties of cultivated oats have probably been derived.

Range of oats.— At present the range of oats production is much more limited than that of wheat. It is more inclined to be a cool climate cereal although not exceeding wheat in its northern range. Within the United States, however, oats are more widely distributed than any other crop with the exception of potatoes. This is due to the high esteem in which it is held as a

[3] Millions of tons.
[4] Five hundred bales.

horse feed and to its adaptation to a rotation in which corn is grown and not to its profitableness as a crop.

Classification of oats.— Beginning with the above division made on the probable origin, oats have been divided into groups and varieties on several characters, such as, shape of head (side or spreading), color of grain (black, yellow, white, red, or gray), awns, character of early growth (spring or winter habit), etc. By the use of these differences, fifty-five distinct varieties have been recognized. However, as in other crops, there is a very large amount of named varieties (five hundred to six hundred). In this number the same varieties have received many names, and similarly, different varieties have received the same name.

Distribution of oats in United States.— In general, in the northern tier of states, including Pennsylvania, New York and all of New England, white oats have grown the best. Most of the varieties belonging to this group are medium to late in maturing and include such varieties as Banner, Silvermine, Swedish Select, Clydesdale, Lincoln, and Welcome. In some seasons with late springs or when seeding is delayed, for some reason early varieties, such as Sixty-Day or Klerson, have proven generally better than other types. Some varieties belonging to this group lend themselves to fall sowing, which is necessary in some regions. Between these two regions lies the corn belt in which a large diversity of oats is grown, but in recent years the earlier varieties which mature before the hot, dry summer sets in, have been growing in favor. The early type is about the only one that is grown to perfection under corn-belt conditions.

Desirable qualities in oats.— In choosing a variety to grow it is well to keep in mind some of the qualities which are essential to good oats, the most important of which may be listed as follows: 1, high yield; 2, early maturity; 3, stiff straw; 4, resistance to smut and rusts; 5, white color; 6, small percentage of hull. The last-named quality of a good variety of oats has been much overlooked. The percentage of hull varies from twenty to forty, and when analyzed is found to be high in crude fiber, ash and nondigestible carbohydrates, and low in protein and fat, which makes it of little value as a feed as compared with the kernel. On the other hand, a low percentage of hull is usually associated with a high weight per bushel. For these reasons, with other things equal, a thin-hulled variety should be grown.

Cultural methods.— The same principles hold with oats as with wheat in regard to preparation of the seed bed, only oats

are less exacting in regard to soil preparation and respond less to fertilizers and manure. On account of oats being a coarse feeder, its soil adaptations are wider than the other cereals. It will do well on any fairly productive soil so long as the climatic factors are favorble. The richest soils and soils high in nitrogen often produce too rank a growth in oats, causing lodging and a consequent loss. So far as fertilizers for oats are concerned, ordinarily, it does not pay as high returns as when applied to other grains. In a rotation including oats and wheat, the fertilizer better be added to the wheat. Fertilizers high in potash (four-six-six) have given very good results in the northeastern states when used with oats.

Generally less preparation of the seed bed has been practiced for oats than for the other cereals. In fact, experiments have shown that on soil in good physical condition, plowing and harrowing have given little increase over disking. It is, however, better to plow the heavy clay soils of the eastern United States, either in the fall or very early spring, than to try to prepare the seed bed by disking.

Time of seeding oats.— Early seeding in the case of oats is very necessary. This is important because the crop is exacting in its climatic requirements, growing to perfection only in a cool, moist condition. This is best fulfilled before the dry weather of mid-summer. Seeding in the south begins in February and is not completed in the north until May, but ordinarily oats should be seeded as soon as the land can be prepared. Slight freezes after seeding do little or no injury.

Rate of seeding oats.— The rate of seeding oats varies from eight to ten pecks, but ordinarily there is little or no increase above ten pecks. The heavier rate is better on a cold, wet soil or on a soil low in fertility where abundant tillering does not occur, while eight pecks are sufficient on a warm, well-drained, fertile soil, where all plants tend to tiller.

The manner and depth of seeding oats are same as for wheat.

Seed treatment for smut.— Where the seed oats is unknown or where smut is known to be present, treatment of the seed to kill the smut spores is very profitable. This can easily be done by dissolving one pound of commercial formalin in forty gallons of water and sprinkling this solution over the seed oats at the rate of one gallon per bushel. The seed should be turned as the solution is added so that all seed will be wet. After the application, the seed should be piled up and covered with bags for several hours, then spread out to dry. This can be done any

time during the winter or spring, the only precaution is to get seed well dried after treatment. In any case the seed should be well dried before attempting the use them in a drill.

Harvesting oats.— Exactly the same methods are employed here as with wheat. The only difference is that oats may, and probably better, be cut before wholly mature, since there is little increase in the kernel during the last stages of maturity, and if harvested when mature there is an actual loss due to shattering.

Market grades of oats.— Oats have been officially designated as white, including yellow, red, gray, black, mixed, bleached and clipped. Each of these groups has been given grades according to the following table taken from the "Handbook Official Grain Standards for Oats" of the United States Department of Agriculture, Bureau of Markets:

GRADE REQUIREMENTS FOR WHITE, RED, GRAY, BLACK, MIXED, BLEACHED AND CLIPPED OATS

GRADE	CONDITION AND GENERAL APPEARANCE	Minimum test weight per bushel	Sound cultivated oats not less than	Heat damaged (oats or other grains)	Foreign material	Wild oats	Other colors, cultivated and wild oats
				Not to exceed			
		Lbs.	%	%	%	%	%
1.......	Shall be cool and sweet, and of good color	32	98	0.1	2	2	2
2.......	Shall be cool and sweet, and may be slightly stained	29	95	0.3	2	3	5
3.......	Shall be cool and sweet, and may be stained or slightly weathered	26	90	1.0	3	5	10
4.......	Shall be cool, and may be musty, weathered or badly stained ..	23	80	6.0	5	10	10
Sample grade	Shall be white, red, gray, black, mixed, bleached or clipped oats, respectively, which do not come within the requirements of any of the grades from No. 1 to No. 4, inclusive, or which have any commercial objectionable foreign odor, or are heating, hot, sour, infested with live weevils or other insects injurious to stored grain, or are otherwise of distinctly low quality.						

With the aid of these standard grades the farmer should be able to determine the grade of his oats before it is taken to the market.

Uses of oats.— Oats find their chief use as a horse feed, for which it has a wide reputation. Many horsemen claim that no other feed is equal to oats in maintaining condition and high spirits. A very large precentage of oats produced is used in this way. Oats likewise make a good feed for sheep and cattle but is not suited for hog feed on account of the hull. Oats likewise have an extensive use as a human food particularly as rolled oats, which, when properly cooked, make one of the cheapest and best food products of the cereals. Long cooking increases both the palatability and the digestibility. Oats have been employed as a human food for many centuries.

Oat straw is used as a roughage and as such is more valuable than the straw of other cereals. When not used in this way it should be employed as bedding, thus being returned to the soil. Even as bedding it has a value of at least three dollars per ton. Consequently, it should never be burned, as is sometimes practiced.

Another important use of oats, particularly on the Pacific Coast, is for hay. When so used it is cut in the milk stage and handled and fed as any other grass or legume. When used as hay it is often sown with field peas or vetch. Hay made in this way is very nutritious and is readily eaten by all kinds of stock.

BARLEY

Barley, although important as a grain crop, is less so both as a world crop and as a crop in the United States, than either corn, wheat, or oats. It ranks seventh in importance among the crops of both the world and the United States as seen from the data given on page 70. The world's production averages about one and a half billions of bushels, of which Europe produces sixty per cent, North America nineteen per cent, and Asia seventeen per cent, the other continents producing comparatively little. Among the countries, Russia is by far the leader, producing about three hundred and eighty millions. The United States ranks second with about two hundred millions, with India, Germany, Austria-Hungary and Japan following in the order named. Within the United States, the leading states are California, Minnesota, North Dakota, South Dakota and Wisconsin, as based on the average production during the years 1914–1918.

This order varies to some extent with the season. The five states above mentioned produce about sixty per cent of the barley in the United States. Very little barley is grown in the corn belt as it comes in direct competition with corn both as a stock food and for the market.

Origin of barley.— Barley, like wheat, has played an important rôle as a food since the beginning of history. It was grown by the people of Western Asia nearly two thousand years before the Christian Era. Specimens have been found in the very old Egyptian tombs and some of the oldest coins bear figures of barley heads. The plant from which barley originated is not definitely known but it is thought by many investigators that a two-rowed wild form found near the Red Sea is one, if not the only, ancestor of our cultivated barley.

Range of barley.— Barley probably has the greatest range of all cultivated crops. It is grown at higher altitudes and latitudes than wheat and is also grown within eighteen degrees of the equator. Certain varieties will mature in 100 days as far north as Alaska, while others in different localities require much longer periods of growth. There are both winter and spring varieties. The winter varieties are less hardy than winter wheat but the spring varieties are much more hardy than spring wheats.

Classification of barleys.— Due to the wide range of production of barley many distinct varieties have been developed, and as in other grains, there is much confusion in the naming of varieties. On account of this confusion some kind of a classification is necessary. The most common classification is based on the number of rows of fertile spikelets and the attitude and width of head as follows:

- Barley
  - Two-rowed
    - Heads lax and nodding (Chevalier, Hanna, Hannchen, etc.)
    - Heads erect and broad (Goldthorpe, Primus, etc.)
  - Six-rowed
    - Heads lax and nodding (Manchuria-Oderbrucher, Featherston, Bay Brewing, etc.)
    - Heads erect and broad (Triumph, Utah Winter, etc.)

Within the four types there are many variations consisting of forms of hulled and hulless; awned and hooded; white, blue, purple and black, etc. It is only the lax types, however, that have become important in the United States. The lax two-rowed types, including Chevalier, Hanna, Hannchen, etc., are mostly grown at the high elevations in North Dakota, South Dakota

and Montana. They are also very important in Canada. The six-rowed types, chiefly Manchuria-Oderbrucher, are grown in the area east of North Dakota and south to the Ohio river. Bay Brewing is the leading barley in California, while in the South winter varieties are employed.

Desirable qualities in barley.— In choosing a variety to grow the following characteristics of a good barley should be considered: (1) Yield; (2) stiff straw; (3) early maturity; (4) thin hull; (5) white or yellow color; (6) uniformity in size of grain; (7) hulled barley; (8) mealy kernel. The last five qualities are more important if the product is to be marketed as these characteristics are very important in malting.

Cultural methods.— Barley is usually grown in the same relative place in a rotation as oats but requires a better prepared seed bed. Consequently it is well to plow in the fall and work the ground early in the spring until a firm seed-bed with a fine mellow surface is secured. If the plowing is delayed until spring it should be done as early as possible to permit of settling. As good results cannot be expected with barley seeded on a poorly prepared seed bed as with oats. When barley is grown as a winter crop it is put in after corn or cowpeas and the soil is simply disked well and seeded.

Rate, depth, and manner of seeding.— The rate of seeding barley is from six to eight pecks per acre. The same principles hold in regard to the effect of climatic and soil factors on rate of seeding as hold in the case of oats. The depth and manner of seeding are the same as for wheat.

Harvesting barley.— Barley is ready to be cut when the kernels are in the hard dough stage and the straw and head golden yellow in color. The handling after cutting is similar to wheat and oats. An extra precaution should be taken, however, to prevent bleaching or weathering if the crop is to be marketed. Bleached, discolored grain has a low market value, but may not be materially damaged for feed.

Uses of barley.— Barley is used chiefly for malting purposes and for stock food. It is also used for human consumption and as hay in the South and on the Pacific Coast. The brewing interests have at least up to date determined very largely the price of barley and also dictated the kind of barley that should be grown. They have been able to do this because such a large percentage of the barley produced has been used for malting. The characteristics of a good brewing barley have already been given and it is the varieties that come up to these standards that

are being grown extensively to-day, namely the lax, nodding yellow or white bearded varieties of the two- and six-rowed forms.

As a stock food, barley has about the same feeding value as shelled corn. It may be fed whole or ground. It makes a better feed for hogs than for other stock. Barley straw is usually not fed on account of the beards which cause injury to the mouths of stock. When used for hay, beardless or hooded varieties are usually employed.

The by-products of brewing also have considerable feeding value. Brewer's grains and malt sprouts are both fed to stock and are a rather cheap source of protein.

RYE

Rye is more important as a world's crop than barley, ranking sixth among the leading crops of the world. However, it stands ninth in importance as a crop in the United States, as seen by the data given on page 70. The world's production of rye is from one and five-tenths to one and nine-tenths billions of bushels per year, over forty per cent of which is produced in Europe. North America stands second as a continent in production, with about three per cent of the total. Russia easily stands first as a country, with more than fifty per cent of the world's production; Germany ranks second, with about twenty-five per cent, followed by Austria-Hungary, United States, France and Sweden in the order named. In both Russia and Germany more rye is produced than wheat. The United States has had an average yield of fifteen and seven-tenths bushels per acre during the period 1914–1918. The leading states in order of their production during the same period were: North Dakota, Wisconsin, Minnesota, Michigan, South Dakota and Pennsylvania. It is only in very recent years that the Dakotas have become important rye producing states.

Origin of rye.—Rye probably came into cultivation about the same time as oats, near the beginning of the Christian Era. Evidence seems to point to Northern Europe as the region of earliest culture. The progenitor of cultivated rye is thought to be a wild perennial form now found growing in Northeastern Europe, but this cannot be definitely proven.

Classification of rye.—In direct contrast to other cereals, rye is represented by only a few varieties varying somewhat in color of grain (white, brownish or green); in shape of head,

and in habit of early growth (spring and winter). Only the white or yellow winter ryes are grown to any extent in the United States.

Cultural methods.—Rye is adapted to a wide range of soil and climate. It can be grown on lighter soil and further north than wheat. It is likewise more resistant to winter injury. It is sometimes known as the grain of poverty, because it can be produced on soils too poor and in too severe climate for other cereals. This ability to overcome adverse conditions does not mean that it will not respond with a larger yield to more favorable soils and climate.

It will pay to prepare the seed bed well when seeding rye, although a fairly good crop can be secured by drilling in corn without preparation, or after the corn is cut off by disking. The rate of seeding varies from five to ten pecks where grain is desired. If grown for straw, a lesser amount is needed, and if grown for green manure even more may be desirable.

The time of seeding rye is somewhat earlier than for wheat, but rye is not exacting in this regard. It may be seeded early and pastured in the fall to prevent jointing, or may be seeded very late so that it barely germinates and yet yields a very good crop. Such extremes are not to be recommended, however, when yield is the prime object.

Rye, like wheat, will respond favorably to fertilization.

Harvesting and threshing rye.—Rye is grown both for the grain and for the straw. When grown for the grain it is harvested and threshed just as wheat, but when the straw is desired the rye is cut while quite green, tied in small bundles, cured carefully and stored inside as soon as possible to preserve the color of the straw. After having been thoroughly cured in this way, the heads only are threshed and the straw thrown aside. The straw thus secured is used for horse collars, upholstering, etc.

Uses of rye.—Rye grain is used for stock food, and for human consumption. The straw is used for bedding and as described above. The green plants are used for pasture and for green manure. Thus it is seen that rye has a greater diversity of uses than most of the cereals. Some of these uses need special mention. Rye bread is the staff of life in some European countries just as wheat bread is in the United States. Rye straw, when of good quality, sells for nearly as much as second-grade timothy on the markets in the big cities. Thus the straw is sometimes worth as much as the grain. Rye makes one of the

best plants for green manures. It grows well in the soils most in need of assistance and is very hardy. As a pasture it can be used both in the fall and in the spring. It can also be used effectively as a soiling crop.

Rotations for small grains.—The advantages of a crop rotation over continuous culture have already been given under corn, likewise a short list of standard rotations. Therefore, they need not be repeated here. Barley and rye do not appear in the rotations, but barley may be substituted for oats and rye for wheat in any of the rotations where it seems to be desirable. Likewise rye may be used in practically all rotations as a catch crop to be plowed under for a green manure.

Small grains practically always follow inter-tilled crops regardless of the rotation. There are good reasons for this practice, as follows:

(1) The inter-tilled crop helps to prepare the soil for the small grains.

(2) Small grains are more delicate feeders than tilled crops and consequently cannot take advantage of coarse manures and organic matter.

(3) Small grains can endure a more exhausted soil than tilled crops.

(4) Permits of equal distribution of farm labor.

(5) Land is kept more fully occupied with crops.

(6) Small grains serve as nurse crops for grass and clover.

The matter of the place in the rotation of any one crop is not so important, however, as the matter of rotating.

Rotation of crops is absolutely essential to an economic system of maintaining soil fertility.

Improvement of small grains.—The same methods are available for the improvement of small grains as for corn, namely: introduction, selection and hybridization or crossing.

Until the present time, introduction in the case of small grains has been far the most important in the United States. This is naturally to be expected since the small grains were grown hundreds and in some cases thousands of years in Europe under very diverse conditions before America was discovered. During that period many varieties with special adaptation were developed, many of which have been introduced into this country and have immediately come into prominence in regions similar to the region from which they were introduced. Several agencies have played an important part in the introduction, namely, United States Department of Agriculture, seed

associations, seedmen and individuals. A few of the important introductions are as follows:

WHEAT — Mediterranean, Fife, Turkey Red, Kubanka, Dawson's Golden Chaff.

OATS — Swedish Select, Klerson, Sixty-Day, Clydesdale.

BARLEY — Manchuria, Hanna, Swan Neck, Hannchen, Smyrna Black.

RYE — Abruzzes, Ivanov, Giant Winter.

It is the second method of improvement, however, in which the average producer can and should take part. Improvement by this method may be made by sorting, by mass selection, or by pure line selection. By sorting is meant the selecting out of mixtures in a given lot and thus purifying the variety, or by sorting out the heavy from the light, or the large from the small seed. Practically all commercial varieties now grown are mixed badly — in fact it is the exception to see a clean field. For this reason effort should be made to eliminate the undesirable types.

Light versus heavy seed.— Much has been said in regard to the value of heavy over light or large over small grain for seed purposes, likewise much work has been done by experiment stations, as the following table shows:

GRAIN	STATION	LENGTH OF EXPERIMENT	LARGEST HEAVIEST	SMALLEST LIGHTEST	CHECK
Wheat	Ohio	8	30.82	30.20	31.06
Oats	Ohio	4	58.98	58.01	58.43
Wheat	Kan.	4	29.13	27.60	29.00
Wheat	Nebr.	11	31.80	31.40	31.90
Oats	Kan.	9	30.90	27.50	29.89
Oats	Nebr.	6	58.80	57.60	58.30

These data show very conclusively that there is very little gain by the use of heavy or large seed, but does not prove that fanning or screening to eliminate weeds, dirt and chaff is not profitable. The only advantage of large and heavy seed is in seasons unfavorable for early growth, at which time more food material is furnished by the larger seed. Where seed is clean and plump it is doubtful if any gain is made by separating out the heavy and large seed for planting.

Mass and pure line or pedigree selection and hybridization as methods of improvement require more time and labor than most producers care to give. Careful and detailed tests must be made,

all seed kept separate, etc. For these reasons they are not discussed in detail here.

Pests of small grains.—The common pests of small grains may be divided into three classes: (1) Weeds; (2) insects; (3) parasitic fungi. The methods most generally employed to combat these pests are: (1) Crop rotation; (2) cultivation; (3) quick growing crops; (4) seed treatment; (5) pure seed.

Weeds as a pest are always present and without exception cause considerable loss by using up the available plant food and water as well as by shading and preventing proper root development of the plants. This loss in the grain fields of Minnesota alone is estimated at $2,000,000 annually.

Weeds are of three classes: (1) Annuals, plants maturing in one year; (2) Biennials, plants maturing in two years; (3) Perennials, plants that grow many years, but seed every year. Examples of these weeds that are bad in grain fields together with control method follow:

CLASS	WEED	CONTROL METHOD
Annuals	Wild mustard Tumble mustard Corn crackle Chess or cheat Common ragweed Wild oats Fox tail	Clean cultivation, rotations, pure seed, and pulling Wheat never turns to cheat, but the percentage of cheat may continually increase because it is not cleaned out of the seed wheat.
Biennials........	Bull thistle Evening Primrose	Prevent seeding by clean culture and rotation, not very troublesome in grain fields.
Perennials..	Canada thistle Morning Glory Quack grass	Summer fallow, deep fall plowing, short rotations, clean cultivation, pasturing with sheep. Any way in which to starve out the underground stems.

Insect pests are of two classes: (1) Those that attack the growing plant; (2) those that attack the threshed grain. The most destructive members of each class are given below with a brief description of method of control:

CLASS	INSECT	PLANT ATTACKED	CONTROL METHODS
Insects attacking growing plants	Hessian fly	Wheat, barley, rye	(1) Delaying seeding until late or until the second brood of adults have disappeared. (2) Burning stubble. (3) Planting a drill width of wheat early for eggs to be deposited on and plowing under later. (4) Crop rotation.
	Clinch bug	Corn, all small grains, grasses	(1) Elimination of dirty fence rows and burning over grass lands in winter to destroy the adults which are hibernating. (2) During periods of migration from one field to another adults may be destroyed by plowing and harrowing finely. Strip 10 to 15 feet wide in their path. Heat and dust overcome the insects.
	Army worm	Corn, small grains, grasses	(1) Plow a furrow around field to be protected and keep bottom of furrow pulverized and sides steep. Worms cannot climb vertically or endure dust. (a) Poisoning a strip around field with paris green.
Insects attacking stored grain	Wheat midge	Wheat	(1) Crop rotation; (2) deep fall plowing; (3) burning of chaff and screenings.
	Granary weevil	Corn, wheat, barley, oats	(1) By heating grain to 118° to 120° F. for a period of 8 to 10 hours. (2) By fumigation with hydrocyanic acid gas (1 oz. potassium cyanide, 1 oz. sulfuric acid and 3 ozs. water to 100 cu. ft. of space). Dangerous. (3) By fumigation with carbon bisulphid (1 lb. to 35 bushels of grain). Place in shallow pan on top of grain in tight bin or box. It then evaporates and settles. Also very dangerous. Any one of these methods are effective in controlling insects attacking stored grain.
	Saw-toothed grain weevil	Grains, Flour, meal, breakfast foods	
	Augoumois grain moth	All cereals, buckwheat	

There are many other insects of minor importance not mentioned above.

Parasitic fungi probably do less damage than either weeds or insects, but the annual loss from fungi alone is estimated at about $50,000,000. The fungi attacking small grains may be divided into three groups: Rusts, smuts, and miscellaneous fungi. The most destructive members of each class are given in the following table, together with methods of control:

CLASS	FUNGI	PLANTS ATTACKED	CONTROL METHOD
Rusts	Orange leaf rust	Wheat, rye	Rusts cannot be controlled, but the damage done may be reduced by (1) using rust resistant varieties; (2) using early maturing varieties to avoid the rusts; (3) seeding early for same reason; (4) avoiding damp, low places, and (5) avoiding over production of vegetative growth.
	Black stem rust	Wheat, oats, rye and barley	
	Crown rust	Oats	
Smuts	Bunt or stinking smut	Wheat	These four smuts are carried from one crop to another by means of spores on the seed and may be controlled when all smut balls have been blown out by (1) formalin treatment already described under oats; (2) hot water treatment used in Europe and to some extent in U. S., but more trouble and less effective than formalin treatment.
	Loose smut	Oats	
	Covered smut	Oats	
	Covered smut	Barley	
	Loose smut	Wheat	No control method, as it is carried within the kernel from one crop to the next. May be reduced by hot water treatment (wheat 10 minutes in water, 129° F.). (Barley 13 minutes at 126° F. after being soaked 4 to 5 hours in cold water.)
	Naked smut	Barley	
Miscellaneous fungi	Ergot	Rye, barley, wheat	Plant clean seed. Does not cause much loss to the crop, but is dangerous when fed to stock.

CHAPTER IV

FORAGE AND SOILING CROPS

BY FREDERIC W. OLDENBURG, B.S.[1]

"Forage crops" includes those plants that are grown primarily to be fed whole, either green or cured, to live stock. Not only does this include the grasses, millets, clovers and alfalfa, but soy beans and cowpeas, corn and sorghum and any other crop when used in this way.

Soiling is the term used when the crop is cut green and carried to the animal. When the finer stemmed plants are cut and cured the resulting produce is called hay. Curing does not mean merely drying, but that under proper conditions a slow fermentation takes place, due to the presence of enzymes in the plants, which gives hay its characteristic aroma. In the North the term "fodder" is used in connection with the corn plant when cut and fed without removing the ears, and "stover" with the ears removed. In the South the term fodder is applied to the dried tops and leaves taken from the standing corn before it is fully matured. Both terms are also used in connection with sorghum, kafir corn and other coarse-stemmed plants.

Distribution.—Owing to the fact that "forage crops" include such a wide variety of plants adapted to various soil and climatic conditions, they are widely distributed over the United States. According to the census of 1909, these crops occupy fully one-half of the cultivated land. However, in some sections of the country they are much more important than in others. In New York and the New England states fully eighty to ninety per cent of the improved land is given over to pasture, hay and forage. This is due to the excellent markets for hay furnished by the big cities and by the dairy interests. In the West, while the percentage of improved land is small, more than forty per cent is occupied by hay and forage. In the Lake States, while the acreage is large, the part occupied by the forage crops is small. In the South the forage crops occupy only five per cent of the improved land.

Varieties.—Timothy and clover mixed is the principal forage crop in the northeastern part of the United States from southern Virginia and Kentucky northward, and east of the Missouri river (see Fig. 1). Corn silage, which is classified as coarse

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forage by the Census Bureau, is also important in this section, while red top and orchard grass are common in parts of New England. Cowpeas and corn fodder stand first in the South, but in the drier regions, in western Texas, Oklahoma and Kansas, sorghum and kafir corn take this place. Farther north, in the spring wheat region, wild and prairie grasses rank first. Alfalfa is the principal forage crop in that part of the corn belt west of the Missouri river and in the irrigated regions on both sides of the Rocky Mountains. On the high plateaus of these mountains timothy stands first, and timothy and clover in the western part of Washington and Oregon. "Grains cut green" are the most important forage crop in California and Oregon.

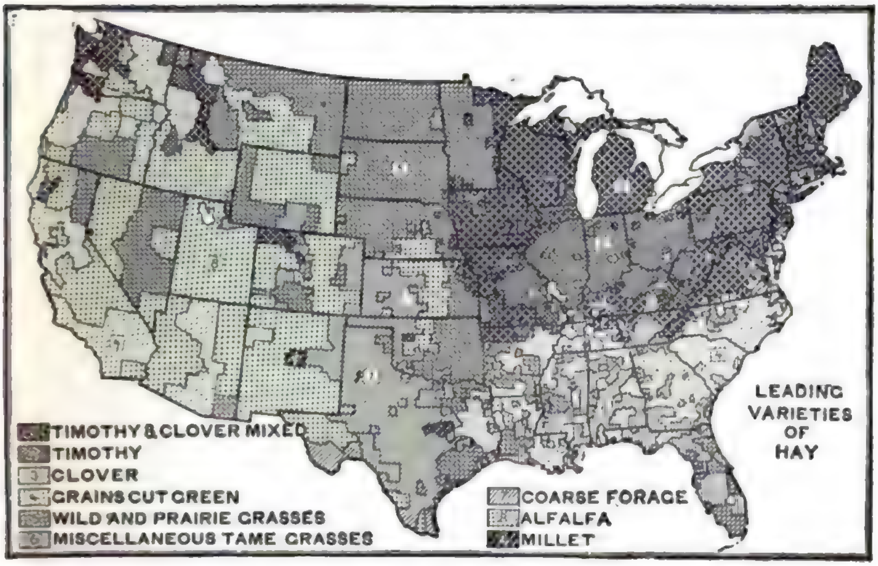

FIG. 22.—Leading varieties of hay.

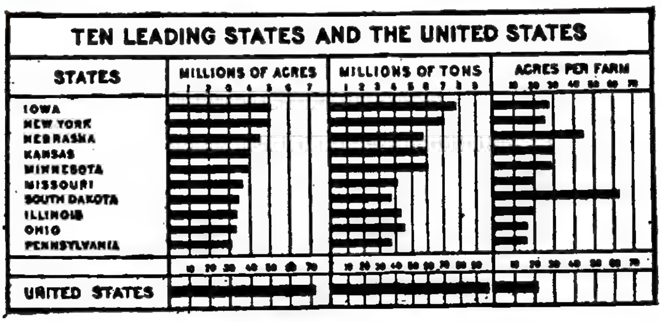

FIG. 23.—*From the Geography of the World's Agriculture, U. S. Dept. of Agriculture, Office of Farm Management.*

ACREAGE, PRODUCTION AND VALUE ACCORDING TO THE CENSUS OF 1909

LEADING VARIETIES	ACRES	PRODUCTION (tons)	VALUE
Timothy and clover mixed	19,542,382	24,748,555	$257,280,330
Timothy	14,686,393	17,085,420	188,082,895
Clover	2,443,263	3,158,324	29,334,356
Grains cut green	4,324,878	5,367,292	61,686,131
Wild and prairie grasses	17,186,522	18,383,574	91,026,169
Miscellaneous tame grasses	4,218,957	4,166,772	44,408,775
Coarse forage	4,034,432	9,982,305	46,753,262
Alfalfa	4,707,146	11,859,881	93,103,998
Millet	1,117,769	1,546,533	11,145,226

Timothy.—In the United States timothy is the most important grass grown, either alone or with clover. According to the census of 1909, there were 14,686,393 acres grown alone and 19,543,382 with clover. This total of more than thirty-four million acres produced nearly forty-three million tons of hay. The reasons for its great popularity are not hard to find. Among these may be mentioned, (1) the cheapness of the seed. This is due to the fact that timothy is prolific in seed production which is easily procured. (2) It yields well and makes an excellent grade of hay, both when grown alone or in mixtures. (3) When cut late it still makes a good grade of hay. (4) It is the best known and in great demand by the city trade.

Much the greater part of the timothy is grown in the region north of the Ohio and east of the Missouri (see Fig. 2). This broad section has the cool humid climate most favorable to its best development. To the westward the climate becomes too dry, to the southward it becomes too hot for favorable production. It is a cool climate crop, and is adapted to the well-drained clay and loam soils of this region.

Rotation.—The most common practice in the timothy-growing region is to have the timothy follow the small grains in the rotation. In that part of the country where winter wheat, corn and oats are grown, the rotation consists of corn, oats, wheat, each one year, followed by timothy or timothy and clover for one to three years or more. In the southern part of the timothy region, however, where oats do not thrive well, the rotation is more often corn, wheat, followed by timothy or timothy and clover. In the more fertile soils of the corn belt it is a common practice to give not more than one year to timothy or to timothy and clover in a three or four-year rotation.

In these rotations the corn may be replaced by potatoes or

some other cultivated crop. Rye, soy beans or cowpeas may take the place of wheat or oats.

Seeds.—Timothy seed has such a characteristic appearance that adulteration with other seeds is almost impossible without being easily detected. While the legal weight is forty-five pounds to the bushel, it may vary from forty-two to fifty pounds. In any sample it will be found that a part of the seeds retain their hulls.

Under good storage conditions seed may retain its vitality for five years, after which it deteriorates rapidly under ordinary conditions. Seed more than two or three years old will generally be found to have deteriorated considerably. Good seed should be about ninety-nine per cent pure and have a viability nearly as high, and will ordinarily germinate in five or six days.

Methods of seeding.—A common practice is to sow timothy with the wheat or rye in the fall, adding clover in the late winter or early spring. The timothy seed is sown by means of a grass seeder attachment that scatters the seed either in front or behind the drill hoes, generally in front, which insures a better covering. Sowing timothy with a winter grain crop has a number of advantages. It enables the timothy to form well-developed roots before the hot summer weather, and since the winter grains are cut earlier than spring grains there is less competition for water on the part of the former. With both winter and spring grains it requires but one preparation of seed bed, but with winter grains the seed bed generally has more time to settle, making a better seed bed for grass than is the case with spring grain.

In much of the timothy-growing region no winter wheat is grown, and the timothy is commonly sown in the spring with oats. This grain shades the ground more and is credited with using more water from the soil than wheat or barley. If, however, oats is used as nurse crop, not more than two to two and one-half bushels per acre should be sown. The grass seedlings will then have a better chance to survive.

When sown with winter grain timothy is not always successful. This is often the case in the southern part of the timothy-growing region where the summers are hot and dry. The more vigorous grain robs the soil of moisture, and after harvest the young timothy plants are destroyed by the sudden exposure to the sun. On fields foul with weeds the timothy may be crowded out, and if there is not a total failure there is at least a decrease in both quality and quantity of the hay.

Where failures occur when sown with winter wheat a common

practice is to sow the timothy alone the following summer. The plan is to sow the grain in the fall as usual, but without the timothy, and as soon as practicable after the grain is harvested the following season to plow down the stubble and prepare a good seed bed. If sown in August a good growth will be made that season, and the crop may be cut the following summer, at the same time as if it had been sown the fall before with the winter grain. Where the growing season is long enough as it is

FIG. 24.—Soil in good tilth. The Meeker harrow is a very efficient pulverizing tool. It consists of a series of small disks fitted rigidly to a straight axle. —*Indiana Experiment Station, Farmers Bulletin 202.*

in the latitude of Virginia, clover may be put in at the same time.

While summer planting makes it necessary to prepare a seed bed especially for the grass, the process will destroy many weeds, making a better quality of hay, and the increased yield will pay for the extra labor.

Seed bed.—A well-prepared seed bed is important. The soil should be well compacted, firm below, with a well mulched surface above. In this condition the seed bed will retain moisture well and give a good start to the seedlings. If the plowing has been done early enough to allow the seed bed to settle thor-

oughly, and if it is well disked and harrowed, it is not necessary to pulverize the surface completely. In fact, under these conditions the ideal seed bed is one covered by fine lumps one or two inches in diameter that have been brought to the surface by the harrow. These small lumps afford winter protection to the seedlings.

Rate of seeding.—The amount of seed sown per acre varies in different sections and with different farmers from eight to thirty pounds. Fifteen to twenty pounds are generally sown. If only eight pounds per acre are planted there are nearly two hundred seeds to the square foot, while one hundred plants to the foot would be a good stand. If mixed with red clover eight pounds of each may be used, and if alsike is included, the following: Timothy, eight pounds; red clover, six pounds; alsike, two to four pounds.

Fertilizers and lime.—As ordinarily grown in a rotation, timothy receives only the residual effects of the fertilizers applied to the grain crops. The practice of applying manure and commercial fertilizers as a top dressing on timothy meadows has shown such good results that many believe that the best results are obtained when used in this way. Manure gives the greatest net return when spread evenly over the whole meadow rather than placing all of it on part of the field. Nitrogen in some form brings the greatest increase. The results with phosphorus are not so striking. These fertilizers should be applied in a soluble form early in the spring just after the first growth starts so that the rains can carry them into the soil. The crop following the timothy shows a decided improvement not only from the residual effect of the fertilizer applied but to the increased amount of root growth plowed under. Whether or not it pays to use commercial fertilizer, especially nitrogen, depends on the relative price of hay and fertilizer and to the increase that can be obtained.

A good top dressing for meadows consists of one hundred to one hundred and fifty pounds of nitrate of soda and one hundred and fifty to two hundred and fifty pounds of acid phosphate per acre, and on soils that need potash fifty to one hundred pounds of sulphate or muriate of potash.

When soils are acid, which is generally the case in the older settled regions, the application of lime will generally increase the yield. With clover and timothy mixtures a decided increase is generally due to the greater growth of clover, for clover receives the greater benefit from the application of lime.

Time to cut for hay.—When the bloom begins to fall or soon after is regarded by most farmers as the best time to cut for hay. If left till the "dough" stage there will be some increase in weight, but some loss in digestibility. While the later cuttings are easier to cure, there is also some loss in palatability. This is shown by cattle; when fed hay alone they will choose the earlier cut hay. However, when they receive other feed with the hay, they show no preference, indicating that the difference in palatability must be slight.

Yields.—While the average yield in the United States is only one and twenty-two one hundredths tons per acre, on good fields it is not far short of two tons, and on rich well-fertilized fields in the Northwest the maximum yield may reach four and one-half tons per acre.

Pasturing timothy.—Continuous and close pasturing may destroy timothy. Each stalk of timothy has a bulb at its base that is easily injured by the trampling of farm animals or by close grazing. In any case a decreased yield of hay may be expected after pasturing timothy closely.

It is, however, a good practice to include timothy in pasture mixtures, for on account of its quick growth it will furnish a large amount of palatable grazing when conditions for its growth are favorable, and by the time it has disappeared the slower-growing plants, such as blue grass and white clover, will have taken its place.

Timothy and clover mixtures.—It is a good practice to sow clover with the timothy. Timothy, like other true grasses, takes plant food from the soil and adds nothing except the organic matter in its roots and stubble. Clover increases the fertility of the soil by adding nitrogen taken from the air by the bacteria that live in the tubercles found on the roots. It also adds more organic matter to the soil than timothy, and is of greater feeding value, being much richer in protein. If a good stand of clover is secured the yield of hay the first year will be more than with timothy alone. The second year the yield is mostly timothy, due to the fact that clover is a biennial and timothy a perennial plant.

In the winter wheat region, timothy is usually sown in the fall with the wheat, and the clover is added in the spring. When early fall planting without a nurse crop is practiced the clover is planted with the timothy.

Both the medium red clover and the mammoth red clover are grown with timothy. Medium red clover matures earlier than

the mammoth and is favored where early cutting is practiced. Where, on account of farm operations, late cutting is the common practice, mammoth clover is commonly grown. Where these clovers fail, alsike clover often succeeds, and should be sown with the timothy. It grows on soils too acid or too wet for the red clovers. Alsike clover matures even earlier than the medium red clover and is generally overripe by the time timothy has reached its best cutting condition. It greatly adds to the feeding value of the hay, however, and, like other clovers, adds to the fertility of the soil.

Life history.—Timothy is a perennial plant, propagated from year to year by means of small bulblets formed each year at the base of the stem about seeding time. The following spring these bulblets send out roots and stems which in turn produce bulblets for the next crop. Timothy usually reaches its maximum growth the second or third year, after which it declines unless the soil is very productive or the sod has been well top dressed with manure, fertilizer, or both.

Redtop.—This is known as Herd's grass in some parts of the South and holds an important place as a forage crop. It is a perennial, with small wiry stems, usually about thirty inches tall, bearing flat leaves about one-quarter inch wide and four to eight inches long. It has an open, erect, many-flowered pannacle. Vigorous shallow rootstalks, two to six inches long, are usually present. These are constantly producing new stalks. When growing isolated, tufts are formed, but in pure cultures a fair turf is produced.

Soil and climatic adaptations.—Redtop has a wider range than timothy both for soil and climatic conditions. It reaches its best growth in a cool climate on moist soils, but it will grow on soils that are either too wet or too dry for timothy. It will withstand more acidity, at least as much cold, and thrive where it is too hot for timothy. It has, consequently, a wider range than any other cultivated grass.

Seed and seeding.—Redtop seed is smaller than that of other commercial grasses, and it should consequently be pure, since foreign seeds can easily be screened out. It is grown chiefly in southern Illinois and is sold in two grades, known as "chaffy" and "recleaned". The former weighs about fourteen pounds to the bushel, while the recleaned should weigh about thirty-six pounds. The latter should be used as it is cheaper and less apt to contain noxious weed seeds. It may be seeded about the same time and manner as timothy. Ten pounds of recleaned

seed per acre or a corresponding amount of seed in the chaff will be sufficient for a good stand when seeded alone. When sown with other grasses four or five pounds are commonly used for hay mixtures, while two or three pounds per acre will be found sufficient for pasture mixtures, as it spreads readily. Timothy, redtop and alsike clover make a good mixture.

Value and uses.—It is the most important hay crop in portions of the New England States. In the rest of the timothy growing states of the Northeast it is second only to blue grass as a pasture grass. The hay is somewhat tough and is not popular on the market. For home use, however, it should be included in hay mixtures, especially if the soil is somewhat sour or wet, for it will increase the yield. The best results are obtained if cut early. After the blossoming period a rapid deterioration in quality takes place. In yield it is exceeded by timothy only. It is the only tame grass that will do well on very wet soils, and it is useful as a soil binder on steep slopes.

The bent grasses.— Redtop is one of the bent grasses, of which there are many varieties. Few have any agricultural importance, for redtop will outyield them all. If the purpose, however, is to establish a good lawn, velvet bent, carpet bent and Rhode Island bent are valuable. They will succeed on soils too wet or too sour for blue grass. Rhode Island bent was formerly quite commonly grown in New York and in the New England States as a pasture grass, but redtop is gradually taking its place. This is due to the difficulty of obtaining the seed of the Rhode Island bent on the market, while the seed of redtop is plentiful.

Orchard grass.— Orchard is a long-lived perennial grass, growing three or four feet tall, forming dense tufts that may become a foot or more in diameter. Its leaf blades are long and flat or slightly keeled and its pannacle is so characteristic that it cannot be mistaken for that of any other grass.

Soil and climatic adaptations.—Orchard grass will thrive on a wide range of soils; doing best, however, under good drainage conditions, on rich loam soils, and well on heavy clays. It will not succeed on poor sandy soils or on muck, but will grow on soils too wet or too sour for timothy and will also withstand drought better. It is grown farther south than timothy because it will stand more heat; on the other hand it is not so common in the North because it is more easily injured by severe winter weather. One of its important characteristics is its ability to

thrive in a partial shade, making it especially suitable to sow in orchards and woodland pastures.

Advantages and disadvantages.—It is one of the first grasses to start in the spring, making the earliest pasturage. As it grows older it becomes unpalatable, unless kept closely cropped, and is avoided by the livestock. It also makes a good late fall pasturage. In meadows, after the hay is cut, a considerable growth starts up, making fair pasturage, and in favorable seasons a second cutting of hay may be expected. To make good hay of orchard grass it must be cut promptly at blossoming time, for after this period it rapidly becomes woody and unpalatable. It is slow to develop; in mixtures taking two or three years to reach the blooming stage. When once established, it is persistent both in pastures and in meadows, but grows in tufts, producing an uneven sod and making it difficult to cut hay. The seed costs several times as much as timothy, and in most regions the yield of hay is smaller.

Seed and seeding.—The seed of orchard grass is grown in Kentucky, Ohio and Virginia. An average yield is about twelve bushels per acre. The seed is very chaffy and on the average a bushel weighs only fourteen pounds. When planting for hay, two bushels of seed are used. In mixtures for permanent pastures, five pounds are used. The seed is too light and chaffy to feed properly through a drill, consequently the sowing is usually done by hand or with a wheelbarrow seeder or other type of seeder. Fall plantings are not often successful because orchard grass is easily winter-killed unless planted very early. It may be sown in the early spring with a nurse crop or in the winter grain as early as conditions allow. For pasture, it is customary to mix other grasses with orchard grass because it does not make a good sod. Redtop and blue grass are often used. For meadows, clover is commonly mixed with the orchard grass.

Kentucky blue grass.—This grass, often called June grass, or simply blue grass, is a narrow-leaved, fine-stemmed perennial, growing from a few inches to two feet tall. It spreads slowly by means of fine underground stems and forms an excellent sod.

Value and adaptations.—Kentucky blue grass is the most important pasture grass, and is second to timothy in total value. It forms a permanent sod that, under favorable conditions, does not deteriorate with age. Not only is it one of the earliest grasses to start in the spring, but it gives late fall pasturage. However, during hot, dry summer weather it makes scant

growth, due to the fact that it is shallow rooted. Unlike most of the other tame grasses, its dry herbage is readily eaten by the livestock; and it starts new growth promptly after rains.

FIG. 25.—Kentucky blue grass.—*Farmers Bulletin 402.*

It grows over a wide range of territory, since it can survive both severe winters and hot summers, and grow on a wide variety of soils. It also succeeds well under irrigation, but is at its best in the timothy and clover region on the soils derived from limestone.

Though seldom used for that purpose on account of the small yield, blue grass makes an excellent hay, containing fully ten per cent protein. After passing the blossoming stage it rapidly deteriorates, and if good hay is to be made it must be cut promptly since it soon becomes wiry and unpalatable.

Seeds and seeding.—Blue grass does not produce seed abundantly, which is generally expensive. As a consequence, in Kentucky, Missouri and Iowa, where most of the seed is raised, while some hand stripping is done, it is largely harvested by machinery that removes the heads, which are then cured and threshed. If heating occurs during the curing process the vitality of the seed is lowered. Indeed, much of the commercial seed has a vitality of only fifty per cent and it may be much lower. Much chaff is usually present in the

seed, which often weighs only ten to twenty pounds per bushel. Seed thoroughly recleaned will weigh ten pounds more.

Because it varies so much in weight and viability, it is hard to determine the best amounts of seed per acre to sow. All the way from twenty to forty pounds per acre are recommended, when seeded alone for hay or pasture, and fifty pounds or more when seeded for lawn purposes. It is always wise to test for germination.

However, on account of the slowness with which it takes possession, taking two years or more to form a good sod, it is nearly always sown with other grasses. For lawn purposes it is wise to make the mixture one-third redtop and two-thirds blue grass, with two or three pounds of white clover per acre added. For hay and pasture, a mixture of blue grass, timothy, redtop and orchard grass with red and alsike clovers added, and sown at the time and in the manner recommended for clover and timothy mixtures, will usually be found satisfactory. Only a few pounds of blue grass seed will suffice in this mixture. The other grasses will develop good pastureage early and will be driven out gradually by the blue grass, which finally will take complete possession. The fact is that a large part of the permanent blue grass pastures were not seeded at all. They were originally covered with native grasses, which have been gradually driven out by the natural spreading of the blue grass.

Canada blue grass.—This is another of the blue grasses that is of considerable importance. It differs from Kentucky blue grass in being somewhat smaller, with a more compact seed head and having a stem that is oval and with a bend at each joint, while that of the latter is round and straight. In color it is somewhat lighter green. It also spreads by means of underground stems and forms an excellent sod.

The seed is cheaper than that of the Kentucky blue grass because it does not have to be stripped from the stem, but when mature the grass can be cut and threshed in an ordinary separator. On account of this cheapness it has often been used as an adulterant in the seed of Kentucky blue grass, which gave it a bad name. It has, however, considerable importance of its own. While not so desirable as Kentucky blue grass where that will thrive on soils too poor or too sour for Kentucky blue grass, the Canada blue grass often takes possession, producing excellent pasturage and sometimes the only hay that could be grown.

Brome grass.—This is a deep-rooted perennial with stems

reaching to the height of four feet. It spreads by means of underground stems and has a tendency to grow in tufts or mats that gradually increase in diameter till in the course of time a dense sod is formed, after which few culms are produced. This grass is therefore better suited for pastures than hay meadows. It is not popular in the timothy and clover region, but it has an important place in that part of the Northwest, having dry and moderately warm summer weather. It is grown chiefly in the Dakotas and northward and westward. On account of its deep root system it produces summer pasturage when shallow-rooted grasses are dried up.

FIG. 26.—Canada blue grass.—*Farmers Bulletin 402.*

Seeds and seeding.— The seed usually weighs only fourteen pounds per bushel, but may vary in weight from twelve to twenty pounds per bushel. For hay, a bushel of seed usually is sown, but for pasture twice that would not be too much, since the brome grass would in that case form a sod sooner. Under semi-arid conditions, it is usually sown in the spring without a nurse crop. If grown in the timothy and clover region, it may be sown at the same time and manner as orchard grass.

Value.—In the semi-arid regions of the Northwest this grass is one of the most important pasture grasses, withstanding dry weather better than any other cultivated grass and at the same time producing a most palatable pasturage. As a hay crop it reaches its maximum growth the third year, after which the yield decreases

rapidly. It is like timothy in the fact that its cutting stage extends over a wide period of time without seriously injuring the quality of the hay. The yield, however, usually is not high.

Secondary grasses.—A number of other grasses are sometimes grown in various parts of the United States. Among these may be mentioned: (1) Tall meadow oat-grass, which has many of the adaptations and characteristics of orchard grass and may be sown with it; (2) meadow fescue which has many of the adaptations and some of the characteristics of timothy. It yields much less and is not so desirable and is therefore little grown. (3) Tall fescues, and other fescues. These grasses have about the same characteristics as (2) and no one is grown extensively in the United States. (4, 5) Italian rye grass and English or perennial rye grass. These grasses are used principally as annual hay crops, for lawn mixtures and for winter pastures in the South. (6) Slender wheat grass. This is a native grass of theNorthwest and is especially adapted to the semi-arid condition of that region. It is also used sometimes in grass mixtures in other parts of the country. (7) Western wheat grass is another native grass of the West. It is characterized by being more alkali resistant than other cultivated grasses.

Millets.— The term "millets" is applied to a number of related plants that are used for forage in this country, and in the old world principally for human food. They are annuals, and their principal use in the timothy and clover region is as a catch crop after some early crop has failed. When cut in the blossoming stage a fair yield of good hay may be expected. In the west, from Kansas northward, they are much more generally grown.

Sorghums.—The term "sorghum" covers a wide range of related plants, among which are a number of varieties that are valuable for forage and for grain. Others are used for syrup production, while still others are used for broom-making.

In the southwest, from Kansas southward, the sorghums are commonly grown, constituting the principal grain and forage crop of that region. The varieties used for syrup production and broom-making are grown quite extensively in the eastern half of the United States.

Soudan grass.—This is a tall grass-like plant, growing five or six feet tall under cultural conditions. It matures early enough to be grown in the north, and produces a good quality of hay. Like the millets, it can be used as a catch crop, but it

gives a higher yield and generally produces a better hay. In the south a number of crops may be cut. It may be broadcasted or sown in rows. In the former case, twenty-five to thirty pounds of seed per acre will be necessary, while if planted in rows five or six pounds will suffice.

The legumes.—This is a group of plants to which peas, beans, clovers and similar plants belong. It is an important group, containing, besides the three mentioned, alfalfa and sweet clover, cowpeas and soy beans, vetches, Japan clover and many others. The two principal characteristics of this group are: (1) Their richness in protein. (2) Their ability to assimilate nitrogen from the air with the aid of bacteria growing in the nodules developed on their roots.

The following table shows the superiority of hay made of legumes:

DIGESTIBLE NUTRIENTS CONTAINED IN 100 POUNDS OF HAY

VARIETY	PROTEIN	CARBO-HYDRATES	FAT	VARIETY	PROTEIN	CARBO-HYDRATES	FAT
Timothy	2.8	42.4	1.3	Sweet clover ..	10.0	37.0	1.5
Red top	4.8	46.9	1.0	Alsike clover .	8.4	39.7	1.1
Orchard grass .	4.9	42.4	1.4	Soy bean	10.6	40.9	1.2
Millet	5.0	46.9	1.1	Cowpea......	9.2	39.3	1.3
Alfalfa	10.5	40.5	.9	Vetch	11.9	37.8	1.8
Red clover	7.1	37.8	1.8	Wheat bran ..	12.5	41.6	3.0

From Henry's Feeds and Feeding

This high protein content makes their feeding value greater for all kinds of livestock, and allows them to take the place of high-priced concentrates to a considerable extent. More than that alfalfa, and to a less extent clover, are very rich in lime content, giving them an added value for young growing livestock and dairy animals.

Legumes are the only plants that have the power of utilizing the free nitrogen from the air. The exact amount they are able to assimilate cannot be stated, for it varies with (1) completeness of the inoculation, (2) condition of the soil, (3) amount of nitrate already in the soil, (4) kind of legume.

The amount of nitrogen taken from the air varies from nothing, in cases where no inoculation has taken place, up to fifty to two hundred pounds per acre in case of complete inoculation. This is equivalent to applying from three hundred to twelve hundred pounds of nitrate of soda per acre.

Free nitrogen will be taken from the air only when the proper

kind of bacteria are present to form nodules on the roots. Generally no special care has to be taken with clovers and other commonly grown legumes to see that the proper bacteria are present, but that is not the case with the more recently introduced varieties, such as alfalfa and sweet clover, soy beans and vetch. When sown for the first time they should always be inoculated with their special nitrogen gathering bacteria.

The proper bacteria for each legume is being spread much faster by the fact that there are only seven groups among the cultivated legumes, each group having the same variety of nitrogen gathering bacteria. These groups are:

1. Red, white, alsike, and crimson clovers.
2. Alfalfa, sweet clover, bur clover, yellow trefoil.
3. Cowpea, Japan clover, peanut, velvet, bean.
4. Garden pea, field pea, vetches, lentil, sweet pea.
5. Soy bean.
6. Garden or field bean, navy, kidney beans, scarlet runner.
7. Lupine, serradella.

Inoculation.— When grown on any soil for the first time, any legume may be inoculated by scattering one hundred to five hundred pounds or more of soil to the acre, from an old field where the same legume (or one belonging to the same group as indicated above), has been previously grown successfully and produced nodules.

If soil is difficult to secure, a small amount may be obtained and thoroughly sifted and well mixed with the seed after they have been made sticky by being moistened with a small quantity of water containing a little liquid glue or molasses and allowed partly to dry. A quart or two of soil to each bushel of seed will be sufficient. When treated in this way each seed will have a thin coat of soil.[5]

All things considered, probably the most satisfactory method of inoculation is to use cultures. These may be obtained from nearly all seed houses. The seeds are simply moistened some time before planting with the liquid. Complete directions come with the culture. Under certain restrictions, limited quantities are supplied by the United States Department of Agriculture and by several experiment stations.

If the soil is rich in nitrogen, legumes will grow well without inoculation, but in that case no part of nitrogen used by them will be taken from the air, and one of the principal advantages of growing them will be lost.

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[5] Wisconsin Circular 96; Bulletin 202, Illinois Experiment Station.

Medium red clover.— Red clover is the most commonly grown and the most important leguminous forage crop. It thrives best in regions having a humid climate and a moist soil not deficient in lime. It will not thrive on soils that have become very acid, but the application of lime will generally make it possible to secure a stand.

Seeds and seeding.—The seeds are generally secured from the second crop of clover. They are produced wherever clover is grown extensively.

When seeded with timothy, eight pounds per acre are used, but when seeded alone ten to twelve pounds or more are commonly used. In the winter wheat region, it may be sown in the grain very early in the spring, depending on the alternate thawing and freezing to cover the seed. Later, when the soil becomes dry enough, the special grass seed drill may be used. Usually all the seed are put in with the seeder going at right angles to the grain drill rows.

Sowing in the spring and in the late summer is also practiced.

Characteristics.— Medium red clover is generally regarded as a biennial. The great majority of plants die at the end of the second year after producing a crop of seeds, but some may live longer if they are prevented from producing seed by pasturing or frequent cutting. Most of the plants that appear after the second year may be accounted for by self-seeding or by the fact that in any ordinary lot of clover seed there are many so-called "hard seeds" that will not germinate till they have undergone the freezing and thawing of a winter or two.

Time to cut for hay.—The clovers are at their best state for cutting at their blossoming period, after which they become woody, and decrease in weight and protein content, on account of the loss of leaves.

Value.— Some of the reasons why clover is so generally grown, besides its high yield and good feeding qualities are: It fits in so well in the usual four- or five-year rotation. The clover or clover and timothy can be seeded with the grain, causing no loss of time, and the following year producing hay and pasture or hay and seed. When the stubble and roots are plowed down, the soil is benefited more than by any other legumes except alfalfa and possibly sweet clover. Fully thirty per cent of the organic matter, and nitrogen of the plant is in the roots.

Mammoth red clover.— This is a larger variety of red clover, blossoming about two weeks later. It is also called sapling clover. It is better adapted to mix with timothy, since both

blossom at the same time. However, its coarser stems do not make such fine hay and generally but one cutting can be secured.

Alsike clover.— This is a thin-stemmed, leafy perennial, having flowers much like those of the white clover. While it is shallow-rooted, it resists drought about as well as the red clover, and has a wider range, for it does not winter-kill as easily and will endure more heat. It will thrive on soils too wet and too sour for red clover and therefore is valuable wherever red clover no longer will thrive and on wet fields. This fact also makes it a valuable addition to grass mixtures.

Seed and seeding.—The seeds of alsike clover are small, and five to eight pounds per acre are sufficient when seeded alone, while in mixtures two to three pounds will suffice. With red top it makes a good mixture for wet soils.

Alsike clover can be seeded and the crop treated in much the same way as red clover. Its blossoming period comes later and it retains its good qualities longer without deterioration. The yield on the average is smaller than that of red clover.

White clover.— This clover resembles alsike, having slender stems, similar flowers and being a perennial. The stems, however, creep along the ground and produce roots at every joint, and in the course of time a single plant will occupy a considerable area. This habit of growth makes it of little value as a hay plant but makes it an excellent addition to mixtures for pastures or lawns. It is able to maintain itself not only by the fact that its creeping stems are producing new plants, but that it is able to reseed itself under pasture conditions by its short heads dropping seed from time to time. Some of these seeds are "hard" and do not germinate for a number of years. The seed are about the same size as those of the alsike, and two to three pounds per acre for pastures, and twice that much for lawn mixtures will be enough.

Crimson clover.—This clover, as its name indicates, has a conspicuous crimson head. In the region where it is most commonly grown, which is along the Atlantic coast from New Jersey southward and in many parts of the cotton belt, it is a winter annual. In this region it is grown principally as a green manure, being sown after an early crop such as potatoes, or in the standing corn, and then plowed down the following spring.

When used for hay it should be cut before the flower heads develop. These heads are covered with hard, stiff hairs, and if found in the hay are apt to cause trouble in the intestines of the horses.

The seed of crimson clover is two or three times as large as that of red clover. After the first year, the vitality of the seed rapidly deteriorates, consequently it is wise to have it tested before buying. Twelve to twenty pounds per acre is usually sown.

Japan clover.— This is a small, thin-vined annual that grows wild in many parts of the South. It will grow as far north as southern Pennsylvania and will thrive on any well-drained soil; its great value, however, lies in its remarkable ability to grow well and form a dense mat on poor, sandy soils. After a few crops, on such soils it is often possible to grow larger plants. When once planted, although an annual, it is able to maintain itself and spread because it readily reseeds itself in the region adapted for it. It is wise to plant this clover on the soils too thin for other clovers, and to include it in pasture and lawn mixtures for the poorer soils.

Sweet clover.— This plant is a biennial and has only recently come to be well known as a forage crop and a soil builder. When young, the plant much resembles alfalfa, but has a bitter taste. When growing isolated, it forms a large bushy plant, five or six feet, or, under favorable circumstances, even eight or ten feet tall, with the ends of its twigs covered with small white flowers.

During the first season the plant grows slowly at first, but by fall may reach the height of four or five feet and even develop some blossoms, especially in the South. Meanwhile, it develops a root system that is characterized by a large tap root which is powerful enough to penetrate the stiffest clay, and in which the plant is storing reserve food. Very early the next spring, from the crown of this root, a number of shoots are sent up, forming the very earliest pasturage.

Live stock will usually refuse sweet clover at first, but after they have once acquired a taste for it, there is no further trouble from this source. The bitter taste in the plant is due to a substance called cumerin, which it contains. Some plants have more than others and old plants have more than new shoots.

Sweet clover will thrive almost anywhere in the United States, on soil too poor or too deficient in organic matter for clover or alfalfa to grow, but the soil must have plenty of lime. Sweet clover requires a very firm seed bed to give it a good start. In fact stands have been obtained when the soil was so hard that the drill could scarcely scratch the ground. When sown on any soil for the first time, inoculation should be practiced.

Seeds and seeding.—The seeds on the market are generally unhulled. These contain a high percentage of "hard seeds" requiring twenty-five to thirty pounds for a seeding, and somewhat less if hulled seeds are used. The seeding may be done at the time it is customary to seed red clover. In the crimson clover region, it may also be sown at the same time and manner as that clover with a good chance of success. When used for hay, it should be cut just before the first blossoms appear or a little earlier, for the stems rapidly become woody thereafter. Two cuttings may be expected. However, care must be taken that it is not cut too low, for, unlike alfalfa, the new shoots do not come from the crown of the roots, but from the lower joints.

Varieties.—Besides the white blossomed sweet clover, there are two yellow blossomed varieties found in this country, one a biennial, the other generally an annual. The biennial variety is much less valuable than the white variety while the annual variety has still less value.

Alfalfa.—This is a deep-rooted perennial legume living for a number of years under favorable soil conditions. A mature plant has a large root up to an inch in diameter, and, when conditions are favorable for its growth, extending many feet into the soil. From the crown of the root many fine stems are sent up early in the spring, and a second set about the time the first begins to show blossoms. The flowers of the common alfalfa are violet or purple in color, and are arranged in head-like clusters.

Alfalfa is best adapted to regions having dry air with a good supply of water in the subsoil. Consequently alfalfa occupies the same place in western agriculture that clover does in the eastern part of the United States. In the West, little difficulty is experienced in getting a stand, on almost any type of soil. In the East, however, where the climate is more or less humid, more precautions are necessary and the soil conditions are more exacting. A deep, fertile, well-drained soil, free of acid, is required. It thrives best in loam soils, with an open subsoil. A stand may be obtained on sandy soils provided enough lime and organic matter is supplied. However, on loose, sandy soils, especially if underlain with gravel, a higher percentage of failures is to be expected. Failure is almost certain on soils underlain, at shallow depths, with hard pan, with a layer of rock, or impervious clays. Neither can success be expected, if standing water is found near the surface, nor if at any time water or ice remains on the surface for any length of time.

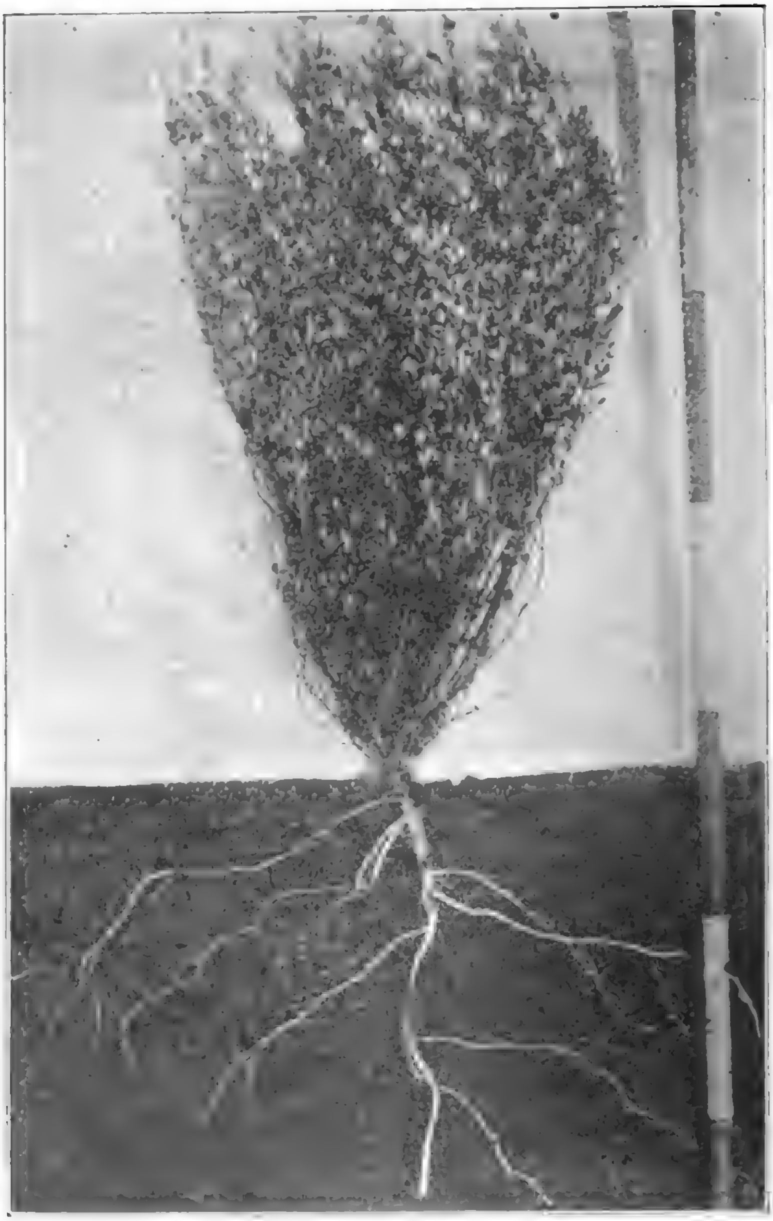

FIG. 27.—A vigorous two-year old alfalfa plant.—*Maryland Experiment Station, Bulletin 118.*

Lime and fertilizers.—To thrive well alfalfa requires both a plentiful supply of lime and of organic matter in the soil. A liberal application of good manure is nearly always beneficial, especially if applied to the seedbed. On older soils three hundred to four hundred pounds of acid phosphate in addition will usually give good results. When sown on any soil for the first time, inoculation should be practiced.

Varieties.— In the North, where winters are severe, the more hardy varieties will often do best. In the great central region, the common variety should be grown, using seed from the northwest, from Kansas northward. In the far South, it is safe to use the southern varieties of alfalfa.

Seeding.—The greatest percentages of successful stands have been obtained by sowing, without a nurse crop, in early August, or even earlier in the far North, after a good seed bed had been prepared early in the season. Early spring sowing is often practiced but the percentage of failures is greater, both when sown with or without a nurse crop.

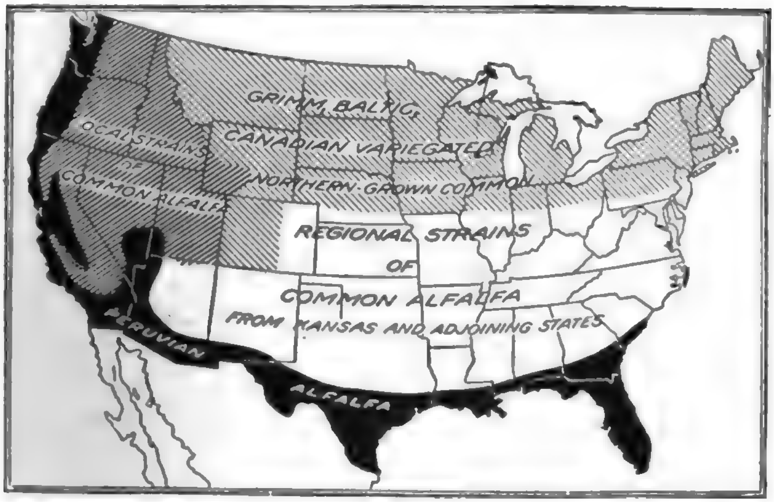

FIG. 28.—Sections of the United States where alfalfa is grown.

Alfalfa should generally be cut for hay when the young shoots at the base of the plants first appear. If cutting is delayed till these young shoots become long enough to be cut by the mower, the next crop may be damaged. The shoots generally appear at the same time as the first blossoms, but they may appear considerably later. Blossoms alone are therefor not a safe guide.

Soy beans.— The soy bean is an annual legume with a stiff

upright stem having the beans clustering around it. Both beans and plant mature at the same time. It is grown for the seed, for hay and for pasture. There are many different varieties and they vary in height from one and one-half to five feet, and from sixty days to two hundred days in time for maturing. Soy beans are adapted to a wide range of soils, but in the South they are replaced by cowpeas on sandy soils, where the latter will outyield them.

Fig. 29.—The soy bean plant.—*Maryland Experiment Station, Bulletin 201.*

If a seed crop is desired, they are planted in rows wide enough apart to cultivate, usually three to four feet. The corn planter may be used to plant them. For hog pasture they are planted in rows about half that far apart. The corn planter may be used, straddling every other row, or the grain drill, by stopping up the proper number of holes. For hay they are planted thicker in the rows, or sown like grain, in which case it will take one and one-half to two bushels of seed per acre. For seed, one-half bushel per acre will suffice. They are a hot weather plant and should not be planted any sooner than the corn.

If planted for the first time on any soil, they should be inoculated.

For hay, they should be cut before there is any danger of losing any leaves, which is indicated by the fact that some of the bottom leaves are turning yellow. For seed, they are left till the leaves have dropped off, when they are cut, dried, and threshed. There are a number of special harvesters that strip the beans from the standing plant.

Soy bean hay is nearly as nutritious as that of alfalfa, while the beans are a very concentrated food, usually carrying from twenty-five to thirty per cent of protein and up to twenty per cent of oil. The oil is self-drying, and can be used in paints. It is also valuable for culinary purposes.

Cowpeas.— The cowpea plant has much the same appearance as the soy bean and is used in much the same way. The planting and cutting is much alike also. It is not grown as far north because there is no variety that matures quick enough for northern conditions. Even in the South the cowpea is being replaced somewhat by the soy bean, for the reason that on the better soils the latter is superior to the former both in yield of beans and forage. On the poorer and on sandy soils, however, the cowpea is the better yielder, and is favored. It is also favored on the smaller farms on account of the ease with which seed may be obtained by picking pods from plants growing in the standing corn.

Field peas.— The field pea is an annual and differs but little from the garden pea, one difference being that some of the flowers of the former are colored. It is quite commonly used in the North as a quick hay crop, and for the same purpose in that part of the South where the winters are mild enough to grow it as a winter annual. The vines are very weak, making it difficult to cut the hay. Oats are commonly sown with the peas, to help hold up the vines. This mixture makes an excellent hay and gives no special difficulties in curing. Two bushels of each are commonly seeded. A yield of two to three tons of hay is often obtained.

Vetches.— The two varieties of vetches most generally known in the United States are the hairy vetch and the common vetch. The former is best adapted for the North and the latter for the South. The hairy vetch will do well on almost any fertile soil, but it has gained the name of sand vetch on account of its ability of doing well on sandy soils.

When planted alone, the vetches are difficult to cut for hay on account of their tangled vines. They are therefor commonly sown with grain. The hairy vetch, which is also sometimes called the winter vetch, is commonly planted in the early fall with rye or wheat. In the South, the spring vetch is commonly planted with oats.

The best time for cutting is when the vetch is in full bloom. Of all the legume hays, the vetch is the highest in protein. On account of the smaller size of the seed, one-half bushel of hairy

vetch and one bushel of grain per acre is sufficient, while one to two bushels of common vetch seed must be used. One of the principal reasons why more vetch is not grown is the relatively high cost of seed.

Hay making.— To make hay of good quality a number of important factors must be considered, such as the condition of the weather, the proper time of cutting, and the proper time and manner of curing and storing.

Weather conditions.—This important factor, of course, cannot be controlled by the farmer. Good hay cannot be made during rainy weather. Much of the damage done by cutting during wet weather could be avoided if farmers did not so generally depend on their own "guess" as to what the weather was going to be. With the daily paper and the telephone available, the farmers now have the weather forcasts of the Department of Agriculture, or can easily obtain them. These forecasts are the work of hundreds of trained observers, working over a wide area, and are very reliable. With more attention paid to these forecasts, less damage by rain would follow.

Proper time for cutting.— The stage of maturity at which cutting gives the best results, varies somewhat with the plant and with the use to which the hay is to be put. The common grasses, when cut at an early stage, and well cured, make a good hay. As a rule, they are cut just as they are beginning to bloom, or just after the bloom has fallen. If cut when in full bloom, the hay is sure to be more or less dusty. If cut after it has reached a more mature state, a greater weight of hay may often be secured, but it will usually be less palatable. In the case of timothy, for home use it is usually cut at an early stage; if for the city market, it is cut at a more mature state. With clover the best results are obtained if cut when in full bloom just as a few heads turn brown. If left till a more mature state, there will be a great loss of leaves, which contain the most protein. Soy beans should be cut when the pods are well filled, and before the bottom leaves turn yellow, while in the case of the cowpeas, the yellow leaves at the bottom indicate that the proper time of cutting has arrived.

Proper curing.— When hay has been properly cured a change has taken place that gives it a characteristic odor and makes it palatable. This change is not simply a drying out but a fermentation, brought about by enzymes present in the plant.

It is well known that rains and excessive dews damage the quality of hay. Excessive exposure to the sun is also damaging.

The curing should be done largely by the action of the air and wind. To understand this, it is well to keep in mind how plants grow. The great amount of water that plants take from the soil, passes up through the stems and branches and escapes to the air through the millions of fine openings in the leaves. This process continues after the plant is cut, the leaves pumping the water out of the stems as it were. If, however, the leaves are exposed to the hot sun, they dry up, the fine openings are sealed up, and the escape of the water in the plant is made difficult. We should therefor "make hay while the sun shines" but allow the leaves to dry in the shade.

Before beginning to cut in the morning, it is well to wait till the dew is well dried off, for this drying will take place quicker with the grass standing than with it lying in the swath. It should be left in the swath only long enough to become thoroughly wilted, and then raked into windrows, where the leaves will continue to pump water from the stems. If the hay is left in the swath till the leaves are thoroughly dry, they will break off when the hay is handled, and much of the best part of the hay will be lost. This applies especially to the clovers and to alfalfa.

Where large amounts of hay are made, it is usual to cure it in windrows, using the side delivery rake and to load with the hay loader. The best hay is probably made by curing in cocks, since there is less exposure to the sun.

Storing.—Hay is best stored in barns or sheds. When stacked in the field there is considerable loss, especially if the stacks are small. In tests made it was found that there was a twenty per cent loss in a ten-ton stack before the first winter and a forty per cent loss when left till the following spring.

CHAPTER V

POTATOES

White potato.— The white or Irish potato, as it is sometimes called, is grown extensively in various parts of the United States. It is one of the most important food products taken from the soil.

THE TEN-YEAR AVERAGE ACREAGE, ACRE-YIELDS, PRODUCTION, FARM PRICE, AND FARM VALUE OF POTATOES FOR THE TEN LEADING POTATO-PRODUCING STATES, 1908–1917

STATE	AVERAGE ACREAGE (acres)	AVERAGE ACRE-YIELD (bushels)	AVERAGE PRODUCTION (bushels)	AVERAGE FARM PRICE DEC. 1 (cents)	AVERAGE FARM VALUE DEC. 1 (dollars)
New York	383,800	93	36,026,100	82	26,853,700
Michigan	345,500	90	31,274,400	64	17,938,900
Wisconsin	283,900	99	28,338,400	60	15,552,200
Maine	128,300	205	25,741,600	71	17,452,100
Minnesota	235,000	100	24,007,500	58	13,310,000
Pennsylvania	284,300	83	23,609,100	84	19,473,200
Ohio	167,300	82	13,745,800	85	10,796,800
Iowa	150,200	80	12,158,900	80	8,671,400
Illinois	141,400	75	10,721,200	89	9,161,800
Virginia	105,600	92	10,034,200	84	9,194,900
Utah	20,600*	162†	3,369,400*	78†	2,682,800*
United States	3,704,400	95.9	356,125,200	76	266,114,800

* Five-year average, 1913–1917.
† Ten-year average, 1908–1913.

Utah Agricultural College

FIG. 30.—Cutting the potato. Leave from one to three eyes on each piece (seed).

Climate.—The climatic conditions in which the potato is grown play an important part in the yield. Where the summers are cool and moist, with a growing season of from one hundred and fifty to two hundred days, is considered the ideal condition for production. Moisture is also an important factor, since the tuber is about seventy-eight per cent water, and the plant requires a moist (not wet) soil to produce a maximum yield.

RELATION OF MEAN TEMPERATURE FOR JUNE, JULY AND AUGUST TO YIELD IN 1909

REGION	JUNE (degrees Fahrenheit)	JULY (degrees Fahrenheit)	AUGUST (degrees Fahrenheit)	YIELD PER ACRE (bushels)
New York	65.0	70.0	67.0	123
Maine	61.9	66.9	65.0	210
Scotland	55.0	58.0	58.0	350

N. Y. State College of Agriculture

Soil.—Both the sandy loam and clay loam are ideal. Heavy clay, or very light, sandy soil are not satisfactory. Clover or alfalfa sods are desirable, but all grass land infested with white grubs or cutworms should be avoided. Land cropped the previous season, left in the rough over winter, incorporated with sufficient well-decayed humus, is most desirable. For a late crop, the sod should be clover, alfalfa, rye or some similar crop. The soil should be moist when plowed, disked, if necessary, and the land formed into a desirable seed bed.

FIG. 31.—One seed potato was used for the production of each plate. Seed (A) was selected from a poor hill and yielded only 1.1 pounds or 56 bushels per acre. Seed (B) was from a highly producing hill and gave 11.1 or 560 bushels per acre. Save the seed from the best producing hill.

RELATION OF ROTATION TO YIELD ON 228 FARMS IN STEUBEN COUNTY IN 1912

ROTATION	MANURE OR FERTILIZER ON PART OF ACREAGE		
	Number of farms	Average yield per acre in bushels	Average number of bushels of seed used per acre
Potatoes, grain, hay	13	177.0	10.9
Potatoes, grain, hay, hay	117	134.9	10.3
Potatoes, grain, hay, hay, hay	62	122.7	10.0
Potatoes, grain, grain, hay, hay	25	150.1	9.2
Potatoes, grain, grain, hay, hay, hay	11	143.0	8.8

N. Y. State College of Agriculture

Rotations vary greatly under different soil, fertilizer and climatic conditions. It is desirable that the crop or crops preceding the potato should never rob the soil of the necessary fertilizer to support a maximum yield. Do not grow potatoes on the same soil year after year.

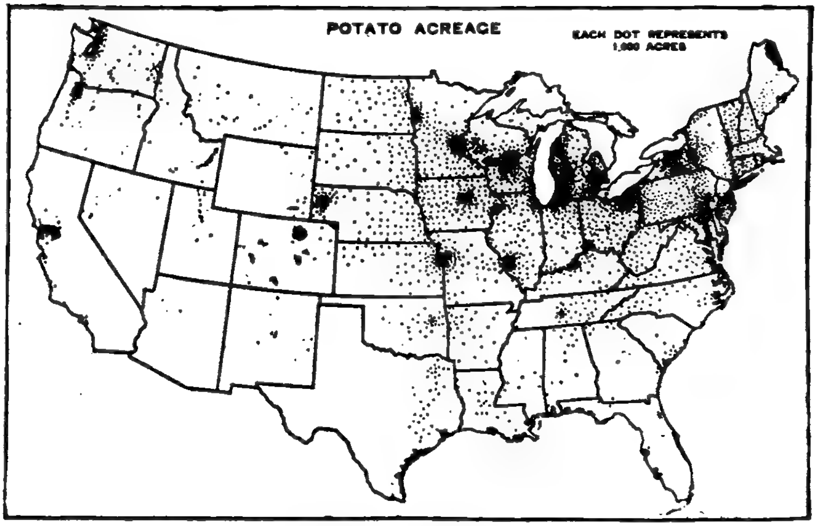

FIG. 32.—Map showing the potato-producing areas of the United States in 1909. —*After U. S. D. A.*

FERTILIZERS FOR POTATOES

BY C. W. WARD, B.S.[1]

Stable manure is the most satisfactory fertilizer for potatoes. It is, however, not always available in sufficient quantity to supply the required amount of plant food. Land on which a good crop of clover or alfalfa grew the previous season may produce a satisfactory yield of potatoes without the application of fertilizer in any form. The yield will, as a rule, be profitably increased on such land if stable manure is applied at the rate of eight to ten tons per acre. On grass land or cultivated land the application of manure should be much heavier, fifteen to twenty tons per acre being desirable under these conditions.

When the supply of stable manure is not sufficient, commercial fertilizer may be used to furnish needed plant food. Some form of commercial fertilizer may be used profitably on nearly all soils in which potatoes are grown. On clover or alfalfa sod-land two hundred fifty to five hundred pounds of acid phosphate per

[1] Extension Specialist, Michigan Agricultural College.

acre may be used. The heavier applications should be made on the heavier types of soil. On land which has not grown clover or alfalfa the previous season a fertilizer containing two to four per cent nitrogen, eight to twelve per cent phosphoric acid, and at least four per cent potash will be desirable. The rate of application of a complete fertilizer should be from five hundred to one thousand pounds per acre. Unleached wood ashes used at the rate of five hundred to one thousand pounds per acre will supply a considerable quantity of potash and a small amount of phosphoric acid.

TIME AND METHOD OF APPLICATION

Manure.— Stable manure will give the best results when used on sod-land if applied in the fall. The best time to make the application of manure is just after the hay crop is removed. Manure applied at that time will stimulate the growth of grass, including the roots of the plants, and thus add organic matter indirectly to the soil. Except on land which is subject to surface washing, it is better to apply manure for potatoes during the winter months than in the spring. If the application of manure is delayed until spring the earlier it is applied the better it will be for the potato crop. Whenever applied it should be spread as it is hauled and not allowed to remain in piles. Manure applied as a top dressing on potatoes does not, as a rule, give satisfactory results.

Commercial fertilizers.— To get the best results from the use of commercial fertilizers they should be so applied that they will be incorporated with the moist soil. The time of application should be either before or when the planting is done. The most common method of application is through the fertilizer attachment of the potato planter. Where hand-planting is practiced, or when the horse planter has no fertilizer attachment, the fertilizer may be applied with a grain drill having a fertilizer attachment. When such tools are not available the fertilizer may be spread by hand evenly over the field and thoroughly disked or harrowed into the soil. When the fertilizer is applied primarily for the benefit of the potato crop the best results will be secured by making the application of all of the fertilizer in the furrow or drill. If, however, it is desired that the fertilizer benefit the following crops equally with the potato crop, a portion or all of the fertilizer should be applied evenly through the soil. When applied in the furrow the residue which is not used

by the potato crop frequently causes an unequal growth of the grain or other crops which follow.

Varieties.— It is difficult to suggest any group of varieties to be raised on a commercial scale, because of the wide variation in the adaptability of tubers to different localities. The following list may be a guide for the farm garden. The varieties are arranged according to the time of ripening.

Beats Them All (Mitchell's), Beauty of Hebron, Bliss Triumph, Early Ohio, Early Rose, and Irish Cobbler. The first five varieties are especially adapted to the North, while the Irish Cobbler does well both north and south. In the northern part of the United States, such varieties as Green Mountain, Sir Walter Raleigh, Rural New Yorker, Carman and State of Maine are grown, while in the South, White Star, Lookout Mountain, and McCormick are prolific producers.

It is suggested that the grower write to his State Experiment Station for advice on the varieties suited to his local conditions, soil and climate.

Seed.— The potato seed should be free from all diseases. The amount of seed required per acre varies from twelve to thirty bushels, according to the size of the seed pieces. Two to three eyes should be in every seed piece. If the seed is selected in the fall for planting the following year, the potato plant should show vigor, health and a high yielding quality. Small whole potatoes from a healthy plant may be planted. Do not plant seed that have been frosted. Potato tops frozen in the fall do not injure the tuber providing the frost does not reach the tuber itself.

Treating seed.— The most effective treatment against scab or black scurf is corrosive sublimate. Dissolve four ounces of corrosive sublimate in hot water and mix with thirty gallons of water. Keep solution away from live stock, chickens, etc., for it is deadly poison. Mix the solution in a wooden barrel or vessel; never use metal. Soak the seed one and one-half hours. Solution may be used for three to four treatments of the tubers. Dry the potatoes before cutting and planting. Do not allow the seed potato to come in contact with any disease after treatment.

Planting.— The time of planting depends on the condition of the soil, temperature and market demands. Never plant in a wet, cold soil. Usually, the rows are three feet apart and the seed dropped eighteen inches apart in the rows. The depth of planting depends on the type of soil and the uniformity of moisture available. On heavy soil, shallow planting is practical and the cultivator works the soil up to the plants during the growing

season. Seed may be planted deeper in light soil. Where there are more than five acres to plant, use a machine. Of the two types generally used (picker planter and platform type), the notched-platform is considered the best.

In hand-planting, draw a furrow with the plow, drop the seed and cover by dragging or with a shallow plow furrow.

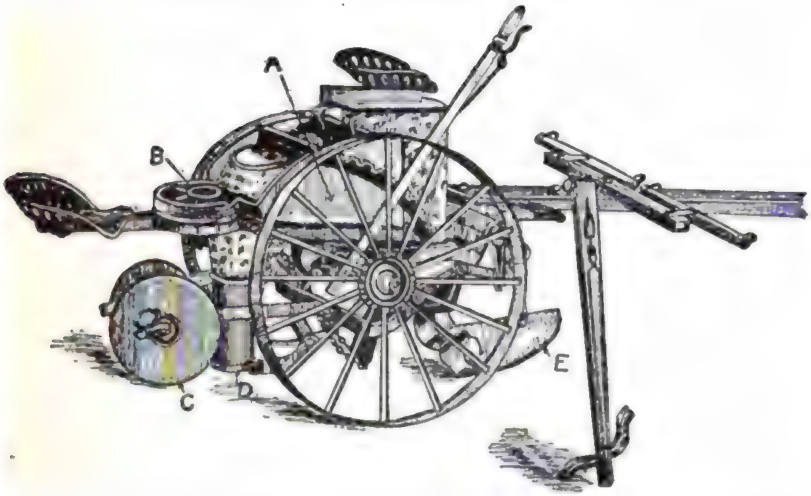

FIG. 33.—Notched-platform potato planter. A, hopper carrying cut sets; B, notched platform; E, furrow opener; D, drop spout; C, covering disks. Two operators can plant nearly all the hills—about 95 per cent efficient. *After Utah Agri College.*

Cultivation.— Before planting, harrow the land thoroughly in order to destroy all weed seedlings. Slant the harrow teeth back and cultivate once after tubers are planted, especially if the soil has become a little crusted from rains. After sprouts appear cultivate deeply, repeat later with a shallow cultivation.

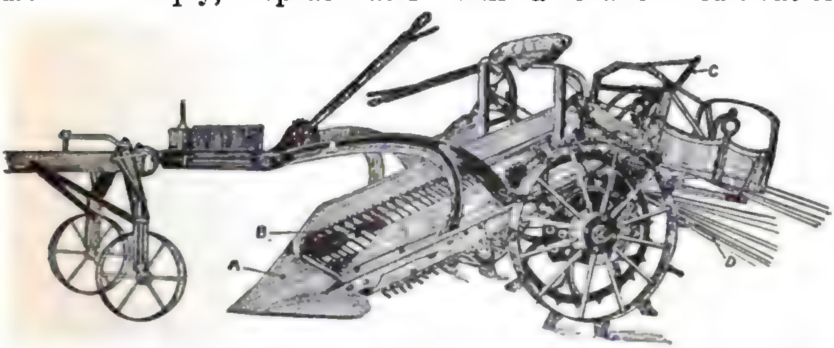

FIG. 34.—Diagram of elevator potato digger. A, blade which passes under hills; B, elevator rods; C, spring release for throwing off vines; D, device for separating very small and very large tubers from medium-sized ones.—*Utah Experiment Station.*

Cultivate often during the growing season. After the plants reach a considerable size, winged shovels may replace the rear teeth of the cultivator and thus throw the soil towards the plant. Keep down weeds throughout the season.

Harvesting.— Where the potatoes are grown on a large acreage, the potato digger, as shown in the diagram, is used. A small digger with bars at the back, which jerks up and down with small arm beneath, is recommended for the small farmer, rather than the plow. Allow the soil and moisture to dry from the skin before picking and sacking. Do not allow the tubers to be exposed to the sun for long. Harvest early varieties when large enough to eat; late varieties, after allowing the vines to ripen.

Grading.— U. S. Grade 1:

Round varieties graded over one and seven-eighths-inch screen.

Long varieties graded over one and three-quarters-inch screen.

U. S. Grade 2:

All potatoes grading over one and one-half-inch screen.

Storing.— Average storage temperature forty-five degrees to fifty-five degrees F. The air should be free from odors, and should have good ventilation. The freezing point of the potato is twenty-six to twenty-eight degrees F. Potatoes may be stored in a pit, well-drained and ventilated. For special information on storage, send for Farmers' Bulletin No. 847, United States Department of Agriculture, Washington, D. C.

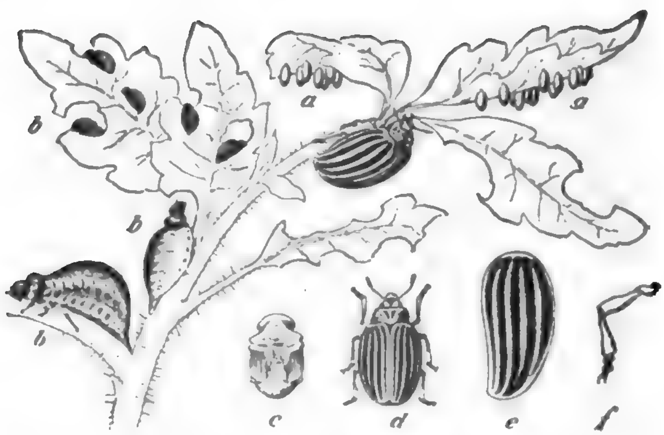

FIG. 35.—Colorado beetle or "potato bug." *a.* egg on underside of leaf; *b.* larva that eats the leaves; *c.* pupa; *d.* imago or perfect insect; *e.* wing-cover; *f.* leg.

FIG. 36.—Potato disease on the leaves.—
After Jonk.

COMMON INSECTS

INSECTS	CONTROL	REMARKS
Potato-beetle	Spray, Arsenate of Lead, Paris Green	Both adult and larva eat foliage Spray as soon as the larvæ appear
Flea-beetle	Repelled by Bordeaux Mixture	Eats small holes in leaves. Found mostly on under side of leaf. This small black insect lives on bitter-sweet, horse-nettles, jimson weed and ground cherry. Destroys weeds
Blister-beetle	Spray, Arsenate of Lead	Controlled when spraying for common potato beetle
Stalk weevil	Burn old stalks	Found mostly in the south central States. An ash-gray beetle, the white grub of which bores in the stalk
May-beetles	Plow sod in fall	Leave the land in the rough over winter and destroy the white grub
Mire worms	Fall plowing	Feeds on the roots and burrows holes in the tuber

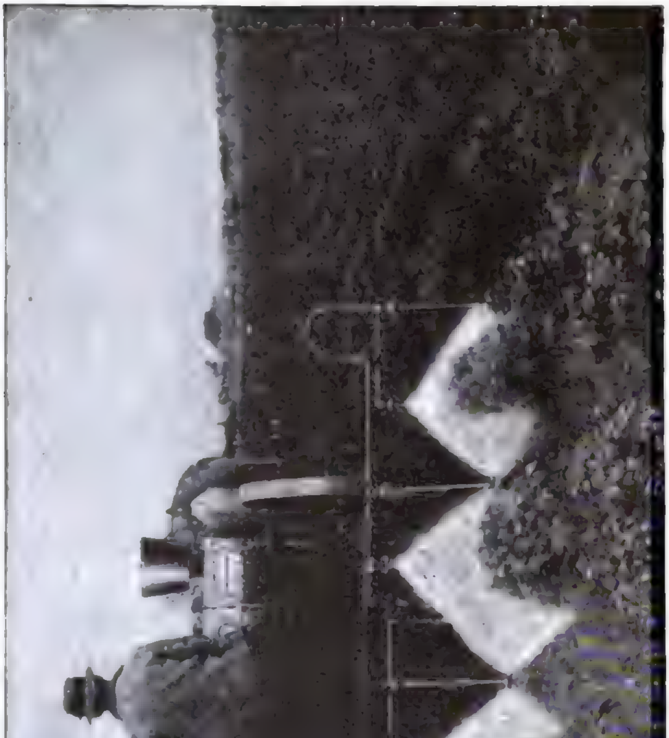

FIG. 37.—Traction sprayer in four rows of potatoes.—*The Baltimore Manufacturing Company, Grenlock, New York.*

Common Diseases

DISEASE	CONTROL	REMARKS
Early blight	Spray, Bordeaux Mixture. Burn dead leaves after harvesting crop	This fungus causes dark brown spots on leaves. The concentric rings increase and destroy the entire leaf. Spray early in the season and repeat several times
Late blight	Spray, Bordeaux, several times during summer and before rains	Leaves turn brown and die; the stem and tuber may be affected
Dry rot	Use clean seed. No remedy	Disease lives in the soil; therefore, do not plant potatoes in the same soil in which disease was discovered
Scab	See seed treatment	Disease lives over winter on tuber
Bacterial wilt	Remove and burn diseased plants	Stems and leaves turn brown, shrivel and finally blacken

CULTURE OF THE SWEET POTATO

By A. G. Smith, Jr., B.S.[1]

The sweet potato belongs naturally to warm climates, since it is of tropical origin. It is now so universally cultivated that it has become a part of the daily food of millions in the Far East, on the islands of the Pacific, and throughout tropical South America. In our own great country, it has been a favorite vegetable for centuries.

In the tropics the sweet potato grows as a perennial where it sometimes blossoms and produces seeds. In all parts of the United States, however, where the potato is cultivated, it is handled as an annual and rarely every produces seeds.

A warm, sunny climate and a long growing season are two of the essential requirements which Bailey gives for successful sweet potato culture. While such ideal conditions in the United States are found chiefly in the southern and southeastern sections, sweet potatoes are grown profitably as far north as New Jersey and Central Illinois where soil conditions are suitable.

Soil.— The soil should be well drained, loose, and warm. Sweet potatoes will grow on a variety of soil types but tubers

[1] Instructor in Horticulture, Virginia Polytechnic Institute.

of the highest quality may be expected from the sandy or sandy loam soils. Fairly heavy clay soils may give a satisfactory yield, but in appearance, flavor, and keeping qualities, the potatoes are inferior to those produced on lighter soils. Light soils, as a rule, are better drained, more easily tilled, and lessen the cost of harvesting the crop. Potatoes grown on light soils have less dirt clinging to them than those grown on clay soils.

Stucky states that when a friable sandy loam soil is properly fertilized and cultivated it gives a larger yield and a better grade of tubers than clay soils.

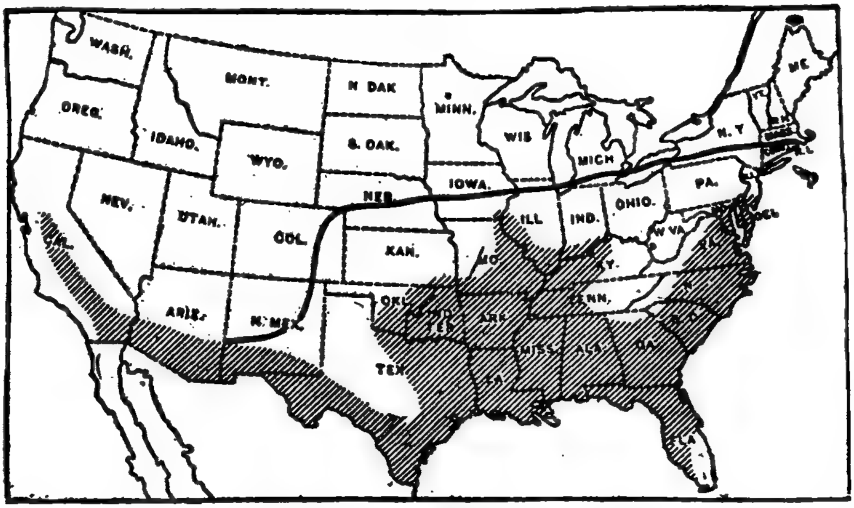

FIG. 38.—Map of the United States, showing the areas adapted to the growing of sweet potatoes. The heavy line represents the northern limits of sweet-potato production for home use. The shaded portion indicates the sections adapted to the commercial growing of sweet potatoes.—*U. S. Dept. of Agriculture.*

Johnson and Rosa found that stiff, clay soils produced excessive growth of vine, while the tubers were long, irregular, rough and inclined to be somewhat watery.

Garcia writes that sweet potatoes do better in a sandy loam than in an adobe soil, and adds that while the best results may be had from a loam which is rich and conserves moisture well, very sandy soils produce low yields.

Rotation.—Sweet potatoes should not be grown on the same piece of ground year after year. Even if the fertility of the soil is maintained by leaving the vines and adding other plant food, the danger of diseases, which may live over in the soil, becomes too great. The sweet potato responds as readily to intelligent crop rotation as any of our staple crops. The following is sug-

gested by Johnson and Rosa for Eastern Virginia conditions: Sweet potatoes, followed by crimson clover or rye; followed by early potatoes with late corn between the rows and rye or cowpeas seeded between the corn at last cultivation; followed by potatoes or any truck crop; followed by sweet potatoes. For Arkansas conditions, Wicks suggests the following three-year rotation: After the sweet potatoes are taken off, hogs are turned on to pick roots, etc. The land is then plowed and a crop of corn with cowpeas between the rows is put in. This is followed by winter oats, which, in turn, are followed by spring cowpeas sown broadcast. The peas are pastured down or cut and followed by sweet potatoes. Such rotations would leave the soil in excellent condition for sweet potatoes. Care should be taken not to plow under heavy crops of rye or clover just before the plants are transplanted to the field.

Preparation of the soil.—The soil should be carefully prepared before setting the plants. It is a fatal mistake to attempt to make the cultivation of the sweet potato during the growing season take the place of the "tillage of preparation." It is necessary to pulverize the soil thoroughly for the best results. Stucky suggests that this may be done best by breaking the land eight or nine inches deep with a two-horse disc plow and following this with a disc harrow.

About a week before planting, the land should be thrown into narrow ridges, about three or four feet apart, by means of a one-horse plow or "sweep." At planting time these ridges are partly leveled by dragging a small log, or any home-made board scraper, down the rows, leaving a smooth, moist surface for the plants.

Sweet potatoes demand a soil which carries a moderate amount of organic matter. This may be supplied in sufficient quantity by turning under cover crops, as previously suggested, or by the use of manures and composts. Where stable manure is used it should be applied to the crop preceding the sweet potatoes. Well-rotted composts may be applied at the rate of fifty to seventy-five tons per acre during the winter preceding planting.

Stable manure, when applied alone to the soil in large quantities, according to Stuckey,[8] gave a heavy yield of vines and a heavy yield of tubers. The potatoes, however, were rough and poor in quality.

Commercial fertilizers.— These fertilizers may be used very profitably on sweet potatoes. However, one should be careful

to provide the plant foods in as nearly the proper proportion as possible.

According to Keitt the sweet potato removes a comparatively small amount of phosphorus, a larger amount of nitrogen, and a very large amount of potash from the soil. The same investigator found the following fertilizer mixture satisfactory on South Carolina soils, when applied at the rate of five hundred pounds per acre:

200 pounds sulphate of potash.
100 pounds nitrate of soda.
400 pounds sixteen per cent acid phosphate.
100 pounds nitrate of soda when vines are eighteen inches long.

Stuckey, who conducted extensive experiments with sweet potatoes , obtained good results on Georgia soils by using the following mixture at the rate of 1,040 pounds per acre:

1,000 pounds acid phosphate.
250 pounds nitrate of soda.
675 pounds cottonseed meal.
300 pounds sulphate of potash.

Duggar and Williamson show conclusively that in many Alabama soils better results may be obtained by heavier applications of phosphoric acid and nitrogen and lighter applications of potash.

From experiments conducted at the Illinois Experiment Station, Durst concludes that only manure or steamed bone applied under the ridge is likely to give any material increase in the net value of the crop, after deducting the cost of the fertilizer.

The following formula is given by Johnson and Rosa, who state that it has been popular among Virginia growers during the potash famine and has given extremely good results:

4 per cent ammonia.
8 per cent acid phosphate.

The amounts of fertilizers to be used must necessarily vary under different conditions, but it would be safe to use from three hundred to five hundred pounds on all soils which have an abundance of organic matter and increase this to one thousand pounds or more on all thin soils that are lacking in organic matter. Where heavy applications are used, it is best to broadcast a part of the fertilizer and drill the remainder in the row.

Experiments, conducted to determine the best form of nitrogen and potash for sweet potatoes, show conflicting results.

Keitt found cottonseed meal slightly superior to nitrate of soda as a source of nitrogen, while Vorhees obtained much better results from nitrate of soda than from cottonseed meal.

Shiver concludes that sulphate of potash is apt to give larger yields than muriate, although either will aid in better production.

Stuckey's experiments show that while nitrogenous fertilizers gave heavy yields of vines, they may or may not give large yields

FIG. 39.—Sweet-potato slips ready to be drawn.—*Virginia Truck Exp. Station, Bulletin 19.*

of tubers. In the same work it was found that acid phosphate alone did not increase the yield of potatoes.

Varieties.—Varieties which gave the largest yields are not, as a rule, desirable for table use, and are usually grown for stock feeding. In the north, the sweet potato is usually boiled, and for this reason a variety high in starch is more in demand than the sugary-fleshed varieties, which are used so generally in the South.

Two varieties of the dry or mealy type are Big Stem Jersey and Yellow Jersey. The soft flesh sorts, which are more popular in the South, are Nancy Hall, Triumph, Porto Rico, and Dooley Yam. Bermuda is the best representative of the larger type which is grown exclusively for livestock.

Propagation.— Sweet potatoes are usually propagated by means of rooted plants or "slips" from the tubers, and by cuttings from the vines. In parts of Virginia and the Carolinas the early vines may be planted for a crop of small potatoes to be used for seed. In the more southern states the main crop is produced from the vine cuttings.

If an early crop of potatoes is desired the slips should be planted in the field as soon as danger of frost is past. It is necessary in such a case to order the plants from a more southern latitude, where the plants may be grown in the open soil; or if home-grown plants are desired, the seed tubers should be bedded in hotbeds where early sprouting may be forced and protection against frost afforded. As a general rule, home-grown plants will make more satisfactory yields than those shipped from a distance.

Hotbeds of the ordinary types may be used for bedding the tubers. These beds are usually six feet wide and as long as desired, in order that the standard sash, which is three by six feet, may be used. In addition to the heat from the sun's rays, hot-beds are usually supplied with artificial heat, which may be obtained from fermenting horse manure or from heated pipes or flues.

In preparing the hotbed for the seed a layer of fresh horse manure should be placed in the bed to a depth of eight to ten inches after it is well packed. The manure should be thoroughly chopped and mixed in order that it may be of uniform texture throughout. If it is dry, sprinkle with water to make it pack evenly. A layer of good sandy soil three inches deep should then be spread over the manure. Use pure sand if it can be secured.

After preparing the bed, cover with the sash and allow the bed to heat for a few days before bedding the potatoes.

The tubers are pressed down sidewise in the soil, far enough apart to prevent touching, and are then covered with two or three inches of loose, sandy soil. The space required to plant a given quantity of sweet potatoes varies with the size of the tubers. More space is needed for a bushel of small tubers than for the same measure of large ones. A bed six by thirty feet should give enough plants for one acre.

The bed should be watered carefully in order that it might not become saturated nor allowed to get dry. Keep the sash on the beds during cold weather and ventilate on warm days by propping up one end of the sash.

Where a very early crop is desired, bed the seed tubers six weeks before the last spring frost is expected. When the slips are drawn from the bed, care should be taken not to pull the mother-tuber out of the soil. The strong plants, which are six or eight inches long, should be used and the smaller ones left for further growth. It is a good plan to water the bed after each drawing, and if this is done plants may be drawn several times at intervals of six or eight days. Do not allow the roots to dry after the plants are drawn. Dip the roots in mud or pack under damp moss or cloth until transplanted.

Time of transplanting.— For earliest sweet potatoes plant as soon as danger of frost is past. This is practiced by many market gardeners who obtain high prices for their first tubers. The largest yields are usually obtained from plantings made after the soil becomes thoroughly warm. Stuckey[8] found that for Georgia conditions slips planted from May 16 to June 11 gave larger yields than those planted earlier or later.

Fig. 40.—Sweet-potato tuber and sprouts.—*Virginia Truck Exp. Station, Bulletin 19.*

Setting in the field.— It is best to set the plants when the soil contains an abundance of moisture. If the soil is wet do not puddle it by pressing too hard next to the slip. Water the plants where the ground is very dry. Garcia states that in the irrigated sections of New Mexico most growers transplant the slips

in the dry earth and irrigate immediately after transplanting. A week following the date of transplanting another irrigation is given. Where irrigation is practiced it is better to plant on one side of the ridge rather than on top or on both sides.

FIG. 41.—Black-rot of sweet potato.—*Farmers Bulletin 714.*

Distances for planting sweet potatoes vary with different varieties and soils. The average distance is three and one-half feet between rows and eighteen inches apart in the row. The vineless varieties, which are rather light bearers, may be planted closer together.

Cultivation.— The cultivation of the sweet potato is easy or difficult in direct proportion to the texture of the land and its freedom from weeds. The essential points in the cultivation are to keep down weeds, to conserve moisture, and to retain the ridges intact. Special tools are provided for the cultivation of this crop, but any implement in common use for white potatoes and cotton may be used successfully for sweet potatoes.

Continue cultivation until the vines almost cover the ground. Remove weeds on the ridge with a hand hoe.

Experiments conducted in several states to test the value of pruning and uprooting sweet potato vines show conclusively that the practice cuts down the yield of tubers.

Harvesting.—Sweet potatoes should be dug before the vines are killed by frost. In trucking sections they are often dug as

soon as the earliest tubers are large enough for market. Such early harvesting may cut down the yield very materially, but the profit may be greater due to the high price for early truck. The digging may be done by using a sweet potato digger which is equipped with rolling coulters to cut the vines, or the vines may be cut with a hand blade and an ordinary plow used to turn the tubers out.

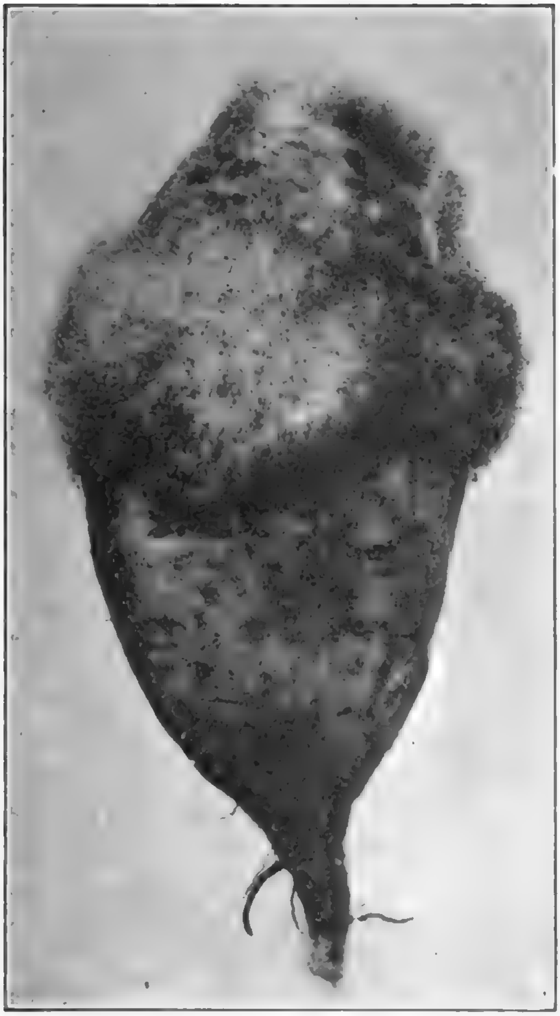
FIG. 42.—Soft rot of sweet potato.—*Farmers Bulletin 714.*

Sweet potatoes should be allowed to dry in the field for a few hours before being hauled to the place of storage. It is best to provide slatted crates of convenient size in which to keep the potatoes throughout the storage period. The tubers are put in the crates in the field. Where such crates are not provided it is best to use smooth containers, such as buckets or pans, in preference to baskets of any description for picking up the potatoes. The potatoes should be handled with the greatest care to prevent scratching and bruising the skins.

Storage.—The keeping of sweet potatoes is one of the most important items in their culture. Were the difficulty along this line removed the area planted would be greatly increased.

The old practice of storing sweet potatoes in pits and carelessly made sheds resulted in the loss of a large percentage of the annual crop. The development of the modern types of sweet potato storage houses has decreased the annual loss to a minimum. While it is impossible in this discussion to give fully the best methods of keeping sweet potatoes, it would not be complete without outlining briefly some of the essential features of successful sweet potato storage.

FIG. 43.—Sweet-potato plant affected by black-rot.—*Farmers Bulletin 714.*

Cure the tubers at a temperature of about eighty-five degrees F. for ten days in order that they may be sufficiently dried to keep. During this period much of the starch is changed into sugar. While this drying is taking place ample ventilation should be provided. Following the drying period a uniform temperature of fifty-five degrees F. should be maintained.

Valuable literature on the subject of sweet potato storage may be obtained free of charge from the Department of Agriculture at Washington and from the various state experiment stations.

Insects and diseases.— The root borer or weevil is the worst insect enemy of the sweet potato. It is found in tropical sections and in several of the Gulf states. The only means of checking it seem to be through the destruction of all infested potatoes and systematic rotation.

Several fungous diseases occur on sweet potatoes and when present may cause heavy losses in the field or during the storage period. Among these are black rot, stem rot, soft rot, and dry rot. The eight rules, summarized from Farmers' Bulletin 714, to save sweet potatoes from fungous diseases are as follows:

Select seeds free from rots or spots of any kind.

Treat seed with a solution of bichloride of mercury (1 oz. in 8 gal. of H_2O) for ten minutes.

Replace old soil in seed bed with new soil, or preferably sand, from a high place in the woods or from where sweet potatoes have not been grown.

After removing old soil it is a good plan to disinfect this bed with a formalin solution (1 pint Formalin to 25 gal. H_2O).

Move the bed every year if possible.

Do not use manure in beds or fields from stock to which sweet potatoes have been fed unless the potatoes were previously cooked.

Burn diseased plants.

Rotate crops.

CHAPTER VI

TOBACCO

BY DR. W. W. GARNER, PH.D.[1]

Kinds of tobacco grown and varieties of seed used.—The tobacco plant will thrive under a wide range of soil and climatic conditions, but only when grown on proper types of soil and under proper conditions of climate will the cured leaf have the necessary properties for commercial use. Several distinct types of tobacco are grown commercially, each adapted to certain uses and requiring for successful production special soil and climatic conditions and cultural methods. The trade can absorb only certain fairly definite quantities of each type at prices which are profitable to the grower. For these reasons tobacco culture has become a highly specialized farming enterprise and is limited to well-defined areas. Generally speaking, it will not pay the farmer to try to grow tobacco commercially outside of these recognized areas.

The four chief commercial types of tobacco are as follows: (1) *Cigar leaf,* used almost exclusively for the domestic manufacture of cigars and grown in the Connecticut Valley of New England, Lancaster and adjoining counties of Pennsylvania, the Miami Valley of southwestern Ohio, and southern Wisconsin; (2) *Flue-cured or Yellow tobacco,* used for the manufacture of cigarettes, smoking and chewing tobacco and for export are grown in southern Virginia, in North Carolina and in South Carolina; (3) *White Burley,* used for the manufacture of chewing and smoking tobaccos and grown in north central Kentucky and southern Ohio; (4) *Dark Fire-cured Shipping,* used for export and for snuff and grown in western Kentucky, adjoining counties of Tennessee, and in central Virginia. Other types of importance are the *Dark Air-cured* of Kentucky and Tennessee, the *Virginia Sun-cured,* and the *Maryland Export.* For growing cigar leaf the Connecticut Broadleaf, Havana Seed, and Cuban varieties are used in New England; Pennsylvania Broadleaf in the Lancaster district; Ohio Seedleaf and Zimmer Spanish in the Miami district; Comstock Spanish and Havana Seed

[1] Tobacco expert.

in Wisconsin. The White Burley is a distinct variety. In Maryland the Maryland Broadleaf and Narrowleaf varieties are grown. For the flue-cured and the dark fire-cured and air-cured types various subvarieties of Orinoco and Pryor are grown.

Soils and soil management.— Both the physical and the chemical properties of the soil greatly affect the properties of the tobacco produced. In all cases thorough drainage is essential to success. The cigar tobacco of the Connecticut Valley, the

FIG. 44.—Crop of cigar tobacco which has been topped and has reached the proper stage for harvesting.

typical flue-cured tobacco of Virginia and the Carolinas, and Maryland tobacco are grown on light sandy and sandy loam soils which are naturally rather infertile. The subsoil also is rather open and sandy except in the Piedmont section of the flue-cured district, where the subsoil is more clayey. The tobacco soils of Wisconsin are sandy loams, light clay loams, and dark "prairie" loams; those of Pennsylvania are fine loams of limestone origin, and those of the Ohio cigar tobacco district are clay loams. The typical Burley soils are the fertile silty loams of phosphatic limestone origin in the Blue Grass region of Kentucky and in southern Ohio. The dark fire-cured and air-

cured tobaccos are grown on heavy brownish or reddish-colored soils containing rather high percentages of clay or silt. In Pennsylvania tobacco is grown in systematic rotation with wheat, grass, and clover. In southern districts the practice of resting the land for a time after growing one or more crops of tobacco has been extensively followed, while in New England, particularly, the common practice has been to grow tobacco continuously on the same land. As a rule, rotation of tobacco with other crops is desirable. Under some circumstances, however, best results cannot be had by growing tobacco after legumes.

FIG. 45.—Tobacco plant, with paper bag placed over the seed head to prevent mixing or crossing with other varieties.

Fertilizers.—Except where the soil is already fertile liberal fertilizing of the tobacco crop is usually profitable. As a rule, liming the soil is less necessary for tobacco than for many other crops. In the cigar tobacco districts barn manure is extensively used. In the Connecticut Valley applications of a ton or more per acre of commercial fertilizers composed of such materials as cottonseed meal, ground fish, quickly available phosphates and sulphate or carbonate of potash also are commonly used. For cigar tobaccos fertilizers containing muriate of potash should not be used. In the flue-cured district commercial fertilizers are necessary and an average application consists of eight hundred pounds per acre of a mixture containing three per cent each of nitrogen and potash and eight per cent available phosphoric acid. Fertilizers of about the same composition are used for the dark fire-cured and air-cured tobaccos, but the average rate of application is somewhat less. Fertilizers are not required in the Burley district.

The seed bed.—The tobacco seed is quite small and the young seedling is very sensitive to excessive heat or drought so that it is necessary to develop the young plant from the seed in a cold frame until it is large enough for transplanting to the field. The soil for the seed bed should be open and mellow, containing sufficient organic matter to retain moisture and to prevent baking and must be well drained. Unless virgin soil in the woods is available, the surface should be sterilized by using surface fires or by steaming. After the soil has been brought to a fine tilth the seed are sown evenly, using a tablespoonful for one hundred square yards of seed bed and covered *very lightly.* Twenty

FIG. 46.—Tobacco curing barn in Kentucky, of the type used for air-curing.

square yards of seed bed should furnish sufficient plants for setting one acre. The seed bed should be covered with glass or cheese cloth supported by a frame of boards or logs. The plants are ready for the field when three to five inches high, that is, six to ten weeks after planting. Seed beds are planted in February in the South, up to and through April in northern districts.

Transplanting and cultivation.—The land should be prepared about the same as for corn, the rows being spaced three to four feet apart. The seedlings should be pulled from the bed and transplanted when the soil is quite moist, if possible, for otherwise watering may be necessary. For considerable acreages on smooth land the machine transplanter should be used, otherwise

setting by hand is practiced. The plants are spaced sixteen to twenty-four inches apart in a row in the cigar tobacco and Burley districts and two and one-half to four feet elsewhere. Clean and shallow cultivation should be practiced. When the flower head appears this should be broken out for the purpose of increasing the development of the lower leaves. In carrying out the process of "topping" the number of leaves left on the plant varies with the type of tobacco produced. Suckers or branches appearing in the leaf axils must also be broken out.

Harvesting and curing.— Sixty to ninety days after transplanting the tobacco will be ripe, as indicated by a change of the deep green color of the leaf to a lighter shade, with the appearance of yellowish green flecks on the surface and a tendency for the leaf to become brittle. Harvesting is done either by cutting off the stalk near the ground or by plucking the leaves at intervals as they ripen, beginning at the base of the plant. The leaves alone or the stalks bearing the leaves, as the case may be, are attached to sticks by means of strings, hooks or otherwise, and hung up in the specially constructed barn for curing. In all methods of curing the rate of drying must be carefully regulated. In flue-curing heat is applied by means of a furnace and pipes extending through the barn. In "fire-curing" slow open fires are maintained on the earthen floor of the barn, the tobacco being thus exposed to the smoke from the fires. Air-curing, in which no artificial heat is used, is employed in the cigar tobacco, Burley, and certain other districts. In air-curing it is essential that effective ventilation be provided. Flue-curing requires three to five days, while air-curing requires four to ten weeks. After curing is completed, as indicated by the midrib of the leaf becoming dry and brittle for its whole length, the tobacco is removed from the barn at a time when sufficient moisture has been absorbed from the air by the leaf to soften it so that it may be handled without breaking. The leaves are assorted into grades according to size, color, freedom from blemishes, etc., and are then tied into small "hands" or bundles in preparation for market. The tobacco thus prepared may be disposed of by private sale at the farm, through sale based on samples displayed by the warehouseman as agent of the grower, or by auction sale on the floor of the loose leaf sales warehouse on a commission basis.[1]

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[1] For further details regarding the growing, curing and handling of tobacco, the series of Farmers' Bulletins on these subjects issued by the U. S. Department of Agriculture may be consulted.

CHAPTER VII

COTTON

By John R. Fain, B.S.[1]

Cotton grown in the United States can be divided into two general classes, the upland and the long staple. The upland can be divided further into the ordinary upland and long staple upland. These classifications are based on the kind of fibre produced. The fibre of the upland cotton usually runs from seven-eighths to one and one-eighth inches in length. Long staple runs from one and one-quarter to about one and one-half inches, while the long staple runs above one and one-half. Some Sea Island as long as two inches is produced.

Fig. 47.—Cotton plant.—*a.* flowering branch; *b.* fruit (boll) bursting; *c.* seed with fibers (lint).—*Itossidlo.*

In general the requirements for a cotton soil are that it should be well drained, should warm up quickly in the spring, and be at least reasonably well supplied with mineral constituents. Cotton is grown on all types of soil from a coarse sand to a stiff clay, and, irrespective of the type, where it meets the above conditions a fair amount of cotton can be produced. A good many bottom land soils are known as cold soils and do not produce cotton. This is unquestionably due to a surplus of moisture. A soil that does not crust is desirable in getting a stand of cotton because the crust interferes materially with the germination of the cotton seed, or at least it interferes with the cotton seed getting out of the ground after germination starts.

One of the principal climatic requirements of cotton is that there should be enough heat units during the growing season to properly develop the cotton. While there are some very early cottons grown, the type that makes the heaviest yield is one

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that has at least a reasonably long growing season. On the northern edge of the cotton belt it is the usual practice to plant the cotton on a ridge so that it will heat up sufficiently quick in the spring to get a quick germination. During the time that cotton is getting established it is rather a delicate plant, but after it is once established it will stand a considerable amount of adverse climatic conditions. A low temperature during this period will retard the growth of the plant very materially.

FIG. 48.—Plowing under the cotton plant after the crop has been harvested.

Therefore, a climate is needed where the spring comes on rapidly, warming up the soil, and without recurring cold periods. After the cotton is once established it seems to thrive pretty well with very little moisture. A dry May is very desirable in getting the plant well started. After this time seasonable showers are necessary to give it the proper growth. Four inches of rainfall per month during the growing season is a fair average for the cotton belt. During the period of harvest, dry weather is essential in securing a good quality of cotton. Rainy, stormy periods will lower the grade and value of cotton very materially.

In planting cotton care should be taken not to get the seed too deep, as it is rather difficult for a seed like cotton to get out of the

ground. The seed is covered with lint that retards its progress through the soil very materially, and as the seed is usually pushed up and the seed cover thrown off after it gets above ground, it can be better understood how this would interfere with its growth. Usually the seed are planted thick and chopped to a stand later. The main reason for planting them thick is that the combined force of many seed can push through the soil where a single seed would fail. In chopping to a stand, plants

FIG. 49.—Preparing the soil for a cotton crop.

are usually left from nine to eighteen inches apart, sometimes further, depending on the type of the land. To facilitate the chopping, often a turning plow is run down either side of the row, leaving the plants on a ridge. After the chopping is over the dirt is thrown back to the plants.

Grass is one of the greatest enemies of the cotton plant and is fought very persistently by the cotton grower. In fact, cotton growers are about the most successful weed fighters that can be found. Cultivators with sweeps are used to a large extent because they give shallow cultivations and are effective weed killers. Weeders or light harrows are used quite often just before and after the crop germinates to clean out the grass and weeds. This is probably the most effective piece of cultivation in the whole operation, as it saves an immense amount of hand labor later on. Most of the cultivation is done with one-horse cultivators. The Planet Junior type ot cultivator is used to a large extent. A good many two-horse cultivators are being used

with good results and will probably be used more and more in the future. It is very necessary to hoe the crop at least once so as to be sure to get all of the weeds that are left by the cultivators. The hand work necessary in the production of cotton makes it a rather expensive crop.

Through most of the cotton belt fertilizers are found essential. A fairly high percentage of the mineral fertilizers with a low percentage of nitrogen is the usual combination. Fertilizer is usually applied in the row with the cotton, and often a second application is applied at the side of the cotton row later in the

FIG. 50.—Diversified farming. Cotton crop in the foreground.

season, although on the majority of the soil types there seems to be very little difference in the yield by applying all the fertilizers at one time as compared with dividing it.

Much of the cotton belt practices continuous cotton cultivation, although in many cases a rotation has been used. For many years a standard rotation was cotton, corn, small grain and cowpeas. Since the advent of the velvet bean and the boll weevil, and the necessity thereby of turning under the cotton stalks, the rotation has been changed to corn and velvet beans, cotton and small grain. From data at hand at this time it would seem that the small grain does better after cotton than it does after corn.

With the advent of the boll weevil many changes in cotton production have been brought about. First, a rotation is more

common than before. The type of plant and kind of seed used have received more attention, as the risk must be reduced to the minimum from other causes than the weevil. It has added a considerable burden to the production of cotton in that all the weevils than can be found must be picked off early in the spring and destroyed, and later the squares that have been punctured and the egg deposited in which the larva will develop must be picked up and destroyed. The culture must be more rapid so as to bring the plant to maturity at as early a time as possible. More study is being given to the fertilization of the cotton plant than heretofore. During a season of hot, dry weather it is possible to keep ahead of the boll weevil pretty well, but during periods of heavy rains in the growing season of the cotton it is very difficult to handle the weevil. The use of calcium arsenate as a poison against the weevil is being used to a limited extent and gives promise of success. This is more effective in a dry season than a rainy one. The cotton stalks are plowed under early in the fall so that the food of the adult weevil will be destroyed and it will go into the winter as weak as possible. In this way a great many of them are destroyed.

The boll weevil does more damage than all the other insect enemies of cotton combined, but there are several insect enemies that in the aggregate do considerable damage. The red spider does much damage at times, infecting cotton fields to such an extent some seasons that the growth is very materially checked and the yield reduced. It is combatted by special cultivation or by sprays. The cotton worm attacks the cotton at times in the latter part of the season. The cotton boll worm or corn ear worm destroys the young buds or bolls and in this way reduces the crop. These two pests are held in check with poisons.

Wilt, anthrocnose and rust are probably the most common diseases of cotton and cause more loss than any other diseases. The wilt is confined to a large extent to the sandy areas of the Coastal Plain, and the only method of combatting it found at this time is by resistant plants. The same method is also employed against anthracnose, while, in some cases at least, fertilization with potash fertilizers will help to reduce the rust.

Information can be had from any of the agricultural colleges or experiment stations in the cotton belt regarding the production of cotton, as this is the main crop, and practically all of them have compiled a considerable amount of data regarding this crop that they are desirous to put at the disposal of those who can use it to an advantage.

CHAPTER VIII

THE FARMER'S ORCHARD

Apple.—An orchard of from one to three acres of early, medium and late varieties will supply apples for family use and have a surplus for sale.

FIG. 51.—Putting lime on the young orchard. For most cases lime should be applied to the land after it is plowed and partly fitted.—*The Country Gentleman*, published by the Curtis Company, Philadelphia.

Location.— Never locate in a shady place. A free circulation of air is necessary; gases, dust and smudge are objectionable. Never locate where the soil is sour, soggy or too dry. Best flavor and color are produced where the fruit is grown at the northern extreme. Plant only varieties suitable to your locality. Exposure to destructive winds should be avoided. Southeastern exposure and as near the farm house as possible is considered best.

Soils.— Rich clay loam, deep and mellow, for Northern Spy, McIntosh, King, Fall Pippin, Wagner.

Garden loam with medium heavy subsoil for Rhode Island Greening and Grime's Golden.

Rich garden loam with very light clay subsoil for Baldwin, Hubbardson, Newton Pippin and Rome Beauty.

FIG. 52.—Cherry trees of the grades illustrated in figures 1 and 2, showing the methods of shaping the tops used when planted: *A*, a two-year-old Large Montmorency, unpruned; *B*, a one-year-old Large Montmorency, unpruned; *C*, same as *B*, pruned to be grown with an open center; *D*, a one-year-old Large Montmorency, pruned to be grown with a central leader; *E*, a one-year-old Schmidt, unpruned; *F*, same as *E*, headed back ready for planting.—*U. S. Dept. of Agriculture.*

FIG. 53.—When this tree was planted the roots were jammed into the hole which was too small. The tip of the root came to the surface and then took a downward course. The photograph was taken when the tree was seven years old.

Varieties.— Buy trees from reliable firms and direct from nursery.

The tree.—Two-year-old trees are considered the best. Head eighteen inches high for sod mulch. Cultivate orchards twenty-four to thirty inches high. Branches should alternate. Opposite branches equal bad crotches. Do not let roots dry out; heel in if land is not prepared. Order trees early.

Planting.— Mild climate, plant in fall. Zero winters, plant in spring. Standard varieties, 30 x 40 feet, 36 trees per acre; small trees, 20 x 30 feet, 72 trees per acre. Dig large holes. Place sod in one pile, loam in another, and the clay-soil (subsoil) in a third.

In planting, fit the fine soil about roots, sod packed in next, and subsoil on the surface.

Prune off all bruised and broken roots. Cut the branches back four to five buds from the trunk. Have the rows straight.

Fillers of cherries, pears, currants, gooseberries and other fruit may be used between the standard trees. Never allow fillers to crowd or shade the apple tree.

Culture.— Cultivate orchard (clean culture), plow in spring, disc harrow after plowing and harrow surface soil frequently.

FIG. 54.— A fine root system. Note the bend in the trunk. This is where the graft was inserted. Plant so that the surface of the ground covers about two inches above where the bend starts.

FIG. 55.— A very bad crotch. The limbs should alternate so that no two would be opposite. Note the tag attached with a wire. If it is not removed it will girdle the limb.

Stop cultivation July 15 to August 1. Do not bruise trees while cultivating, wrap harness with burlap.

Plant cover crop July 15. This prevents injury from frost and washing, checks fall growth, adds humus and nitrogen, protects the fruit, and holds leaves and snow.

Cover crops.— Barley, 8 to 10 pecks seed per acre; rye, 6 to 8 pecks seed per acre; turnips, 2 to 4 pounds seed per acre; buckwheat, 3 to 5 pecks seed per acre; clover, 8 to 14 pounds seed per acre; vetches, 1 bushel.

If companion crops of beans, squash, cabbage, turnips and other late maturing crops are planted in the orchard, mulch trees

with manure. Do not pile the manure about the trunk. Place manure on soil where water drips from the foliage, for this is where many of the feeding roots are located. Sod, mulch, cut cover crop and place material over surface soil where the water drips from the leaves. Usually no fertilizer is necessary where the sod mulch method is practiced.

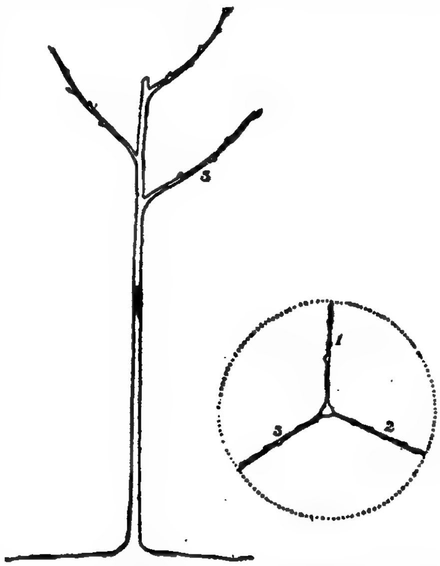

FIG. 56.—Plan of tree at planting time.—*U. S Dept. of Agriculture.*

Fertilizer for clean culture.—Three-year-old trees: One pound dried blood, one pound bone meal, one-half pound nitrate of soda per tree. Increase a little each year. Stable manure is the best fertilizer.

Fertilizer for twenty- to twenty-five-year-old trees: Four hundred pounds basic slag and two hundred pounds sulphate of potash.

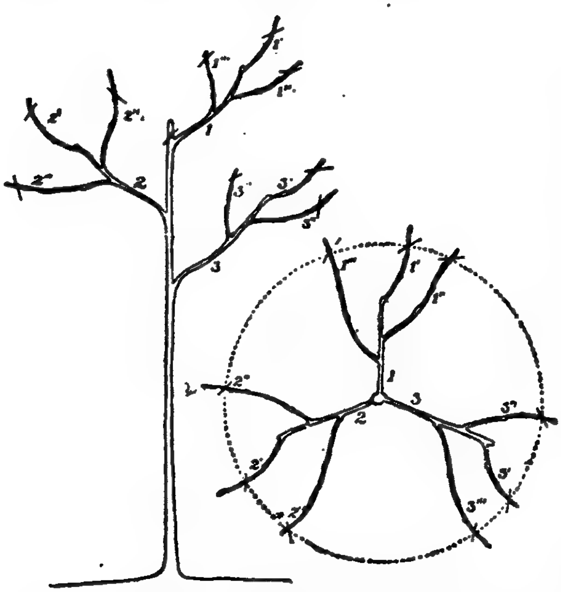

FIG. 57.—Plan of top after one year's growth in the orchard.—*U. S. Dept. of Agriculture.*

Prune a little each year.—Do not leave stubs. Use only sharp saw with small teeth. Paint all wounds over one inch in diameter. Do not over-prune, but keep head open so there may be a free circulation of air through the limbs. Never allow limbs to crowd, rub or cross.

Thinning.—Thin in July, when fruit is size of a quarter. Leave one apple to a spur. The vitality that would naturally go into the seed of a

heavy crop, if thinned, will go into the fruit spur for the following year. Eliminate "off" years.

Harvesting and storage.—Handle apples like eggs. Line baskets with burlap to prevent bruising. Do not pull out or break off the stem or the fruit bud. Pick fruit before it is dead ripe. Place clean straw on shelves before storing apples. Do not harvest while damp or pile in heaps. The fruit cellar should be clean, well ventilated, and the temperature thirty to thirty-three degrees Fahrenheit.

Winter protection.—Place small mesh wire screens about the trunks of young trees. Protection from mice, woodchucks and other animals is necessary. Make protector firm and stationary by the use of two to three stakes. Tar paper and thin wood may be used, but remove early in the spring to prevent sun-scald. It is not necessary to remove wire protectors each year.

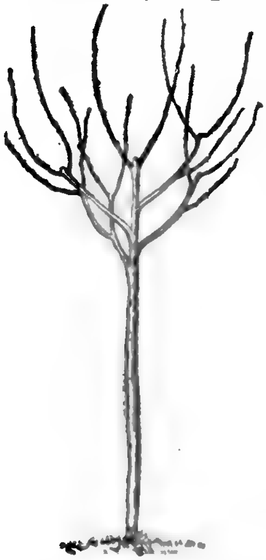

FIG. 58.—A five-branched tree at the end of the first season's growth. —*U. S. Dept. of Agriculture.*

Renovating the neglected orchard.—Many orchards throughout the country are unprofitable because they have been neglected. The trees have not been sprayed, or pruned or cultivated for years and have fallen into decay. Both insects and disease infest such orchards and leave their destructive marks.

Many of these trees may be reclaimed if properly treated and made to yield a remunerative crop.

In order to determine whether or not the orchard is worth reclaiming one must decide the following points:

1. Is the orchard situated in low land (pocket) so that the early frost destroys much of the bloom? If so the trees will never be worth the time and money necessary to rejuvenate them.

2. Is the orchard exposed to the drying winds of winter and the fall winds which whip off the fruit? In this case a wind break of poplar trees may be planted and the difficulty partly overcome.

3. Has the site good air and sufficient drainage? If on a hillside or slightly rolling land the air will circulate freely. The cold air will roll down hill and the summer breezes prevent, to

a large extent, several of the fungus diseases. The trees will never retain their vigor or bear satisfactory fruit if there is an excess of water in the soil, hence the necessity for good drainage.

4. How badly are the trees diseased and decayed? Here the owner must use his own best judgment. If, after the dead limbs are dug out, but little of the tree remains, and that part diseased, it seldom pays to try to reclaim it. If, on the other hand, the dead wood is cut out, the suckers and water sprouts removed, and the head opened up so there is a free circulation of air among the branches, and there is still a well-formed, rounded head, not too high from the ground, the tree is worth saving.

FIG. 59.—Method of cutting a large limb which should be avoided.—*U. S. Dept. of Agriculture.*

Many of the diseases may be controlled by spraying, as suggested in the spray calendar.

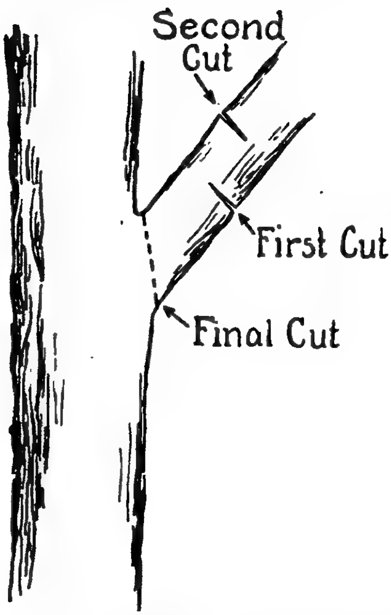

FIG. 60.—Removing large branches. Splitting down often occurs in removing large branches. There will be little chance for trouble if the branches are cut away as indicated in the drawing.—*Wisconsin Bulletin 269.*

5. How old are the trees and are they vigorous? Usually an apple tree after it is forty years old, providing it has been neglected for several years, is hardly worth saving; cherries, after twenty years; pears, twenty years; plums ten to fifteen years; and peaches ten to fifteen years.

Frequently apple trees sixty years old may become valuable if they have a sound trunk, rounded head exposing considerable leaf surface and a good root system.

6. How tall are the trees? If the heads are so high that it requires a double extension ladder to reach the fruit the trees are hopeless. Sometimes by pruning out the top the head may be brought down.

7. Are the varieties desirable? If not, the trees may be worked over by cleft grafting. The cions,

if taken in the fall, should be secured from bearing trees of a desired variety and packed in moist sand in a cool place. If

FIG. 61.—Proper method of cutting off a large limb.—*U. S. Dept. of Agriculture.*

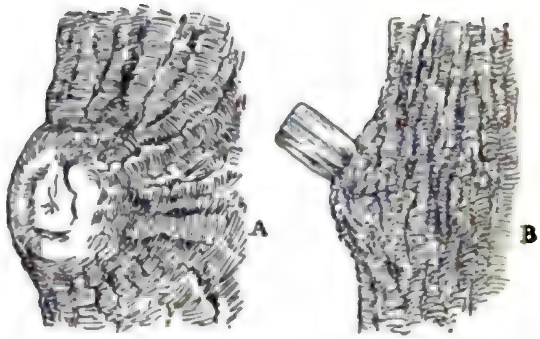

FIG. 62.—Results of correct and incorrect pruning. A, correct method; after two years; B, incorrect method.—*U. S Dept. of Agriculture.*

taken in the spring they must be cut before the buds start. The wood should be of the previous year's growth.

Grafting is simple and may be done in the following way: The cion should have three buds; it should be cut on both sides of the lower bud so that a wedge is formed, the bud side being wider than the side opposite. The cion should be cut on a slant about one-half inch above the upper bud. The tip buds are seldom used.

FIG. 63.—Different states of the San José Scale (enlarge five times).. *Virginia State Crop Pest Commission Bulletin 1904. Massachusetts Dept. of Agriculture Circular No. 6.*

In preparing the stub, never cut a limb at a knot or when it is over three inches in diameter. Cut the limb off squarely and split it with a grafting knife just far enough to insert the cion. The bud side should be out and the lower bud level with the top of the stub. Place

two cions on each stub so that the growing tissue of the cion coincides with the growing tissues of the stub. Cover the top and split sides of the stub and the upper tip of the cion with grafting wax. This should be done a week before the buds start. After the grafts grow for a year, cut out one of them to prevent a bad crotch. Work over one-third of your tree each year. The cions, if inserted into the limb of a bearing tree, will bear fruit in three to four years.

8. Are the trees crowded so that the head has a tendency to reach up for the light? If so it might pay to cut out every other tree. Do not de-hort the trees with the hope of giving the head more room. The branches usually run to water sprouts and the tree never recovers from the shock if the entire head is cut away.

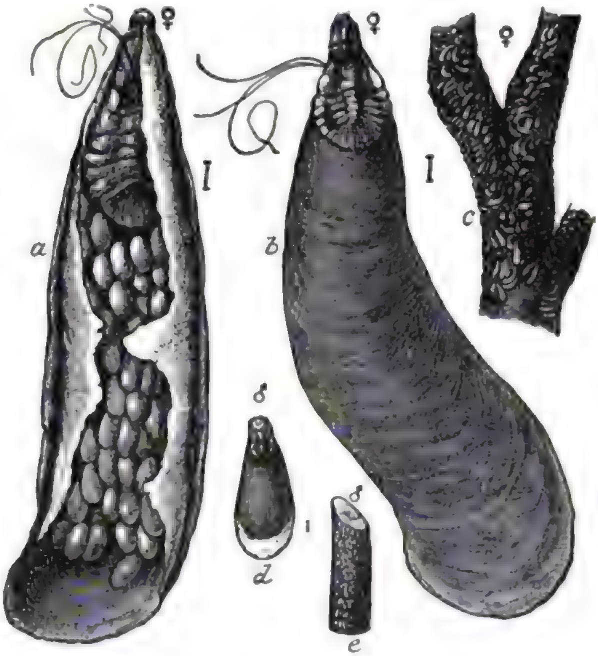

FIG. 64.—Oyster Shell Scale. *a.* under side of female scale, showing eggs; *b.* upper side of same, both much enlarged; *c.* female scales on a branch natural size; *d.* male scale, much enlarged; *e.* male scales on branch, natural size. The file lines to the right of *a*, *b*, and *d* show the real length of the scales.

If you have decided that the orchard is worth saving then you should prune. Use a sharp saw with small teeth. Cut out all dead limbs and limbs that cross. Cut at the collar of the limb and never leave a stub. Do not over prune. Paint all wounds over one inch in diameter.

Next graft the head if the varieties are not desirable. The tops should be well pruned first, then a root pruning should follow.

A light, shallow plowing and frequent cultivation is advisable. Cultivate the surface soil so as to form a dust mulch and stop cultivating in July, then plant a cover crop, as suggested in a previous paragraph.

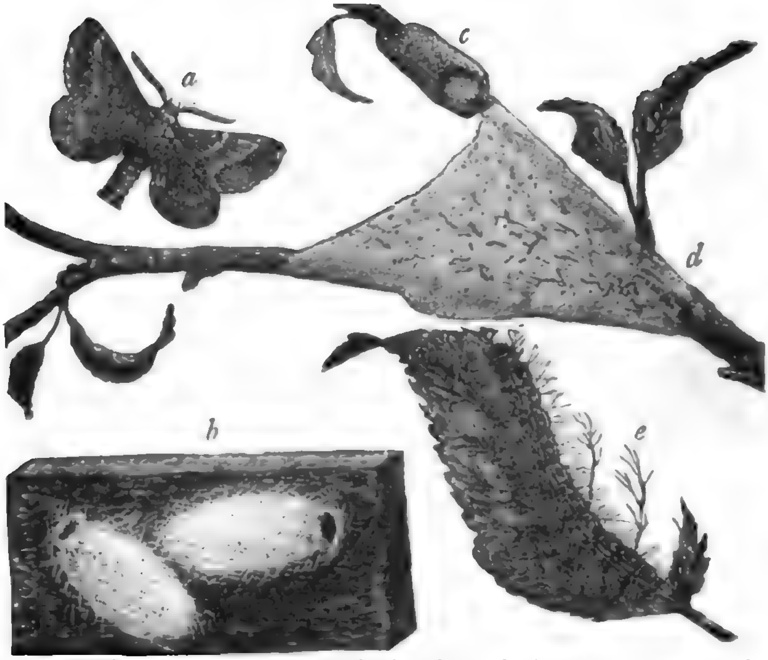

Fig. 65.—The tent caterpillar. *a*, **the female moth;** *b*, **cocoons;** *c*, **mass of eggs;** *d*, **caterpillars on the web;** *e*, **larvae.**

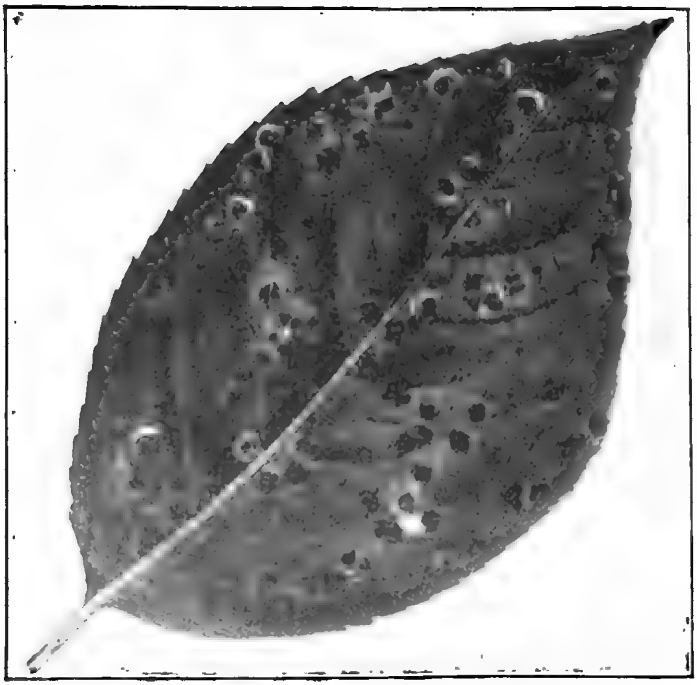

Fig. 66.—A spot disease of apple leaf.—*After Soraurer.*

If the soil is very poor a light coating of barnyard manure may be applied in the fall. If three hundred to five hundred pounds of phosphoric acid and two hundred to two hundred and fifty pounds of sulphate of potash per acre is applied the results are good. Never apply a nitrogenous manure in any form after the orchard has been pruned.

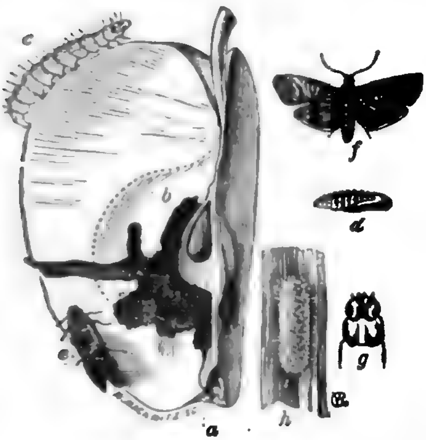

FIG. 67.—The coddling moth. *a* is the burrow; *b* the entrance hole; *c* the larva; *d* the pupa; *e* moth at rest; *f* moth with wings spread; *g* head of larva; *h* cocoon containing pupa.

If cultivation cannot be practiced then keep the grass cut short and mulch the trees with it.

The winter spray, one to eight, lime and sulphur, should be applied before the buds start, but after pruning. The summer sprays as suggested in a previous paragraph.

Burn all prunings and clean up the orchard before the bloom appears.

FIG. 68.—Bitter rot of apple.—*After Clinton.*

Pears.— The pear is the most luscious of any of the fruits, but it is much the most difficult to grow. It may be grown to some degree of success in various types of soils which are well drained. Whenever possible, plant the trees on a northeast exposure in order to keep the buds back in spring and thus prevent the possible injury from late frosts.

TIME	MATERIAL	FOR WHAT
 Before buds start	DORMANT Lime-sulfur 1 to 8	Scale, blister mite
 When leaves of blossom buds are out $\frac{1}{4}$-$\frac{1}{2}$ inch	DELAYED DORMANT (If this spray is applied it will not be necessary to make the "dormant" application) Lime-sulfur 1 to 8 "Black-leaf-40" $\frac{3}{4}$ pt. in 100 gals. (Arsenate of lead 5-6 lbs. in 100 gals.)	Scale, blister mite Aphis (Leaf roller, case bearers)
 When blossoms show pink	BLOSSOM-PINK Lime-sulfur 1 to 40 Arsenate of lead 5-6 lbs. in 100 gals. ("Black-leaf-40" 1 pt. in 100 gals.)	Scab Bud moth, case bearers, etc. (Dark apple red-bug)
 When the last of the petals are falling	CALYX Lime-sulfur 1 to 40 Arsenate of lead 5-6 lbs. in 100 gals. ("Black-leaf-40" 1 pt. in 100 gals.)	Scab Codling moth (Bright apple red-bug)
To be determined by weather conditions and control of scab	LATER SPRAYS Lime-sulfur 1 to 40 Arsenate of lead 5-6 lbs. in 100 gals.	Scab Codling moth, other caterpillars

FIG. 69.—Apple spray schedule.—*New York State College of Agriculture.*

Soil.— A clay loam with a deep, porous subsoil is considered the best. In preparing the soil it should be well incorporated with humus, green manure, such as clover preferred, but stable manure should also be added. If the young trees are to be planted in a clay loam make sure that it is well drained in the fall previous to planting. Cultivate the soil, leaving it in the rough over winter. In the spring disc and harrow the surface and then dig the holes fifteen feet each way, one hundred and ninety-three trees per acre (dwarf trees). Standard pears, plant fifteen by thirty feet, ninety-six trees per acre.

FIG. 70.—One-year-old pear tree. The line shows where to cut back at time of pruning.—*U. S. Dept. of Agriculture.*

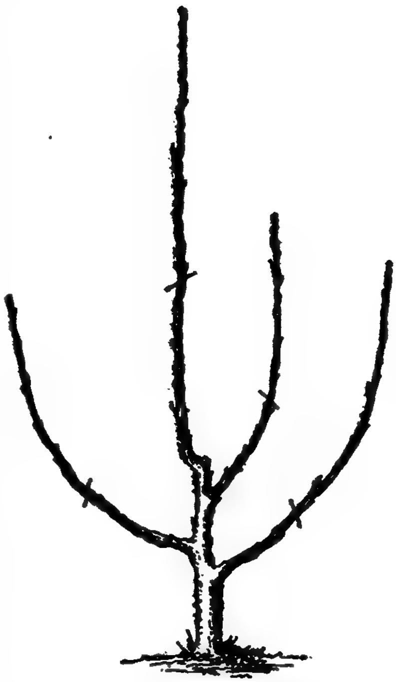

FIG. 71.—Two-year-old pear tree. The lines show where to cut back at time of pruning.—*U. S. Dept. of Agriculture.*

Planting.—Place a little decayed sod and fine top soil in the bottom of the hole before setting the trees. Prune off all bruised or broken roots before planting. Remove all long whip-like roots to within six inches of the trunk. The tree should be set in the middle of the hole with the fine, rich top soil worked in around the roots and tramped down firmly. Set the trees about three inches deeper than they were planted in the nursery. The depth of planting in the nursery is shown by the soil line on the bark.

It is not advisable to plant more than two rows of any one variety together, because some of the varieties are infertile. Rows have pollenization in the orchard in order to insure fruitfulness. In general, spring planting is considered the best.

Cultivation.—A light harrowing of the surface soil is desirable if the orchard is under cultivation. Stop cultivating about July

1 and plant cover crops, as suggested for the apple. In many sections the trees often begin to fruit when cultivation is discontinued.

Fertilizers.— Barnyard manure or green manure such as clover turned under in the spring will insure fertility in the soil. Where a commercial fertilizer is used, six hundred pounds per acre of 2–9–10 is recommended.

Pruning.— All pruning should be done early in the spring before the sap flows. Cut out all limbs that cross and form the head, as symmetrically as possible, allowing the sunlight and air to reach all parts of the tree and thus prevent the deadly action of blight. The branches, on the other hand, should not be exposed to the direct rays of the sun. Maintain sufficient foliage to protect the bark. On starting the top, cut back the leaders to about twelve to fourteen inches from the ground. Each year for four years cut back the young growth to about half and always keep the head of the tree low. Old trees may be cut back severely and allowed to build a new head. The young growth should be pruned so as to keep the head the desired shape and height. Pears are sometimes planted close to a wall and tied to a trellis. The branches are trained fan-shape, and this method of culture is not only artistic but productive.

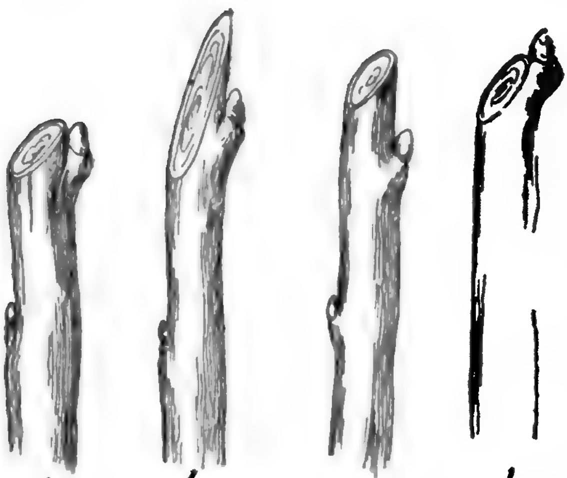

FIG. 72.—Right and wrong ways of cutting off shoots. *a*, the right way; *b*, *c*, *d*, wrong ways.—*U. S. Dept. of Agriculture.*

Thinning.— It is always advisable to thin the fruit, leaving the pears from three to six inches apart on the limb. This should be done when the pears are quite small, less than the size of a quarter.

Harvesting.— For keeping, gather pears before they are dead ripe, and place on shelves in a dark, cool room.

Insects and disease.— One of the worst insect enemies is the

San José scale which attacks the bark and sucks the sap from the growing cells. Spray before the buds open with a strong solution of lime and sulphur, one part of sulphur to eight of water.

The codling moth does some damage but is easily controlled with the same preparation and method as that used on the apple tree.

Pear scab may be controlled by spraying with Bordeaux Mixture or lime sulphur, summer mixture one to forty.

Pear blight or fire blight is the worst disease. It attacks various parts of the tree causing the tips of limbs to wither and die and the bark on the trunk and limbs to shrink, tighten close to the wood and become sunken black blotches. This disease is prevalent where the soil is very rich and the tree has grown soft and rapidly. No remedy has yet been discovered. Cutting out the diseased areas and spraying with lime and sulphur may check the disease. Buy varieties that are less subject to its attack, such as the Seckel, Angouleme, and Kieffer.

Plums.— For a limited planting about the home, the trees are most generally planted on the lawn, and in sod. The soil should be moderately fertile and well drained. While the plum thrives best in a clay loam, yet it will succeed in almost any kind of soil.

Make the holes large so as not to crowd the roots. Place the sod in one pile, the fine, mellow surface soil in another, and the subsoil in a third pile. Place some of the mellow soil mixed with two pounds of bone meal to each hole, in the bottom. After packing the mellow soil around the roots, fill in the sod and finally the subsoil. Cut off all broken or mutilated roots and prune back the top or branches so as to form a symmetrically headed tree.

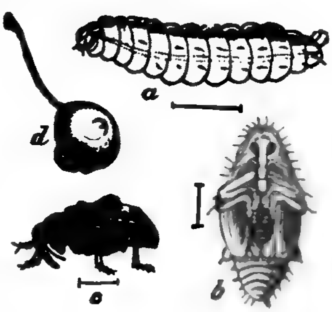

FIG. 73.—The plum tree curculio. *a*, the larva; *b*, the pupa; *c*, the beetle; *d*, curculio, natural size, on young plum.

The plum tree requires considerable moisture to complete the development of a crop. After planting in the early spring, fifteen to twenty feet each way, mulch the surface of the sod with straw or coarse manure. If the trees are planted on cultivated soil, form a dust mulch about them and continue to cultivate. Of course where there is sufficient rainfall to keep the soil moist, mulching is not altogether necessary. If the cultivation is dis-

continued about July 1, sow oats and Canada field peas mixed, or rye and vetch as a cover crop to protect the roots in winter. Dig this green manure under in the spring.

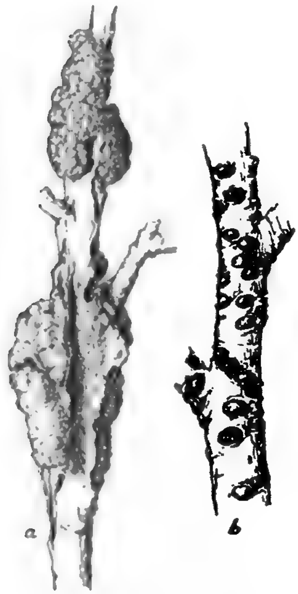

FIG. 74.—Black knot. *a*, on plum; *b*, on currant. Cut out infected parts two to three inches below the diseased wood. Burn all diseased wood. After pruning spray the trees with Bordeaux mixture.—*After Massee.*

If the "framework" of the tree has been properly constructed (low, loose head), little pruning will be necessary after the fifth year's growth.

Thin the fruit so that the tree may produce each year and the remaining fruit will be larger, a finer texture, and better flavor. The plum curculio is controlled with the same solution as suggested for the same insect on the cherry.

To control the brown rot, pick off all the "mummies" or rotten plums after the foliage has fallen. Spray with Bordeaux mixture.

Cherries.—All low-lying land should be avoided for both the sweet and sour cherries. The sweet cherry, if grown with any degree of success, requires a deep, sandy loam, so exposed (northeast) that the blossoms will be held back until all danger of frost has passed. A southern exposure not only causes the buds to break early but often causes sunscald. The sour cherries are hardier than the sweet varieties and do well in a light clay soil.

The sweet cherry should be planted twenty-four feet each way, seventy-five trees per acre, while the sour cherry has ample room at eighteen feet each way, one hundred and thirty-four trees per acre. Both should be planted early in the spring, set firmly in the soil and the surface of the soil cultivated until July 15 when a cover crop should be planted, clover, rye or vetch. If crops are grown between the trees continue cultivation until September and then mulch with straw or manure. After the trees come into bearing (five years) apply each spring one-half wheelbarrow load of manure, two pounds of bone meal, and one pound of muriate of potash to each tree working this fertilizer into the first three inches of soil.

Both the sour and sweet cherries require very little pruning after they come into bearing. Keep the head low, remove all

limbs that cross, also all dead branches or twigs, cut out and keep the limbs open enough to allow a free circulation of air through the tree. The best growers head their trees about eighteen inches from the surface of the ground at planting time. There is a wide difference of opinion as to time and methods of pruning. In general, prune early in the spring before the buds start. After the tree comes into bearing, very little pruning is required.

The general culture in the treatment of the soil is similar to that recommended for the pear or plum.

The three insect enemies that the average grower has to encounter are cherry fruit fly, plum curculio, and pear slug. The cherry fly is about two-thirds the size of the house fly. It appears in June. The female stings the fruit and lays her eggs under the skin. The maggot is full grown about the time the cherry ripens. Spray with one-half pound arsenate of lead to seven gallons of water. Before spraying add one pint of cheap molasses. The molasses attracts the fly and the poison kills it. Spray when the Early Richmonds show signs of red.

The plum curculio is a grayish-black beetle which lays her eggs in the green cherry. Clean away brush piles and weeds and cultivate. Spray with arsenate of lead the same strength as used for the cherry fruit fly.

The pear slug in the larvæ stage is a small, blackish slug which feeds on the upper part of the foliage. Spray with arsenate of lead.

The principle disease of the cherry is the brown rot, causing the cherries to decay. Allow sunshine and a free circulation of air through the branches. Destroy all diseased fruit after harvesting and spray with Bordeaux Mixture.

Birds are sometimes a common enemy of the cherry tree. Cover the tree with mosquito netting. One dollar will buy enough to protect a six-year-old tree.

Peaches.— In past years it was thought that the peach was partial to a sandy type of soil, but it has been demonstrated beyond a doubt that the peach will grow on any type of soil that will grow corn or potatoes. A sandy loam with a light clay subsoil is especially desirable because of the adequate supply of moisture, warmth of the soil drainage, and general physical condition.

If peaches are grown in a commercial way, the orchard should be located where the transportation facilities are close at hand. The orchard site is influenced by elevation, bodies of water and

slope (see Farmer's Bulletin No. 917, United States Department of Agriculture).

Planting.—"As a rule, only thrifty, well grown, well rooted one-year-old or June budded trees free from injurious insect pests and fungous diseases should be planted." Plant in the spring. Never allow the roots to dry out; heel the trees in. Trees planted 18 x 18 feet, one hundred and thirty-four trees per acre, 20 x 20 feet, one hundred and eight trees per acre. Plant in straight rows and do not crowd the roots. Set the trees two to three inches deeper than the nursery planting. Remove all mutilated roots with a sharp tool. Prune back the head vigorously after planting. Fit the finely pulverized soil about the roots and pack it down firmly.

FIG. 75.—Wounds made in pruning. Left—Wound improperly made. Do not leave stubs. Center—The proper place to make the cut. Right—The properly made wound heals rapidly.—*Wisconsin Bulletin 269.*

Cultivation.—In general, peaches thrive best on land that is tilled each year. Plow early in the spring and harrow the surface soil so that there is a dust mulch. Stop cultivation about mid-season and plant a cover crop of red clover, crimson clover, vetch, or rye, oats, etc. No special commercial fertilizer can be safely recommended.

Pruning.—The principle objects sought in pruning may be summarized as follows (United States Department of Agriculture Bulletin No. 917):

1. To modify the vigor of the tree.
2. To keep the tree shapely and within bounds.
3. To make the tree more stocky.
4. To open the tree top to admit air and sunshine.

5. To reduce the struggle for existence in the tree top.
6. To remove dead or interfering branches.
7. To renew the vigor of the tree.
8. To aid in stimulating the development of fruit buds.
9. To secure good distribution of fruit buds throughout the tree.
10. To thin the fruit.
11. To induce uniformity in the ripening of the fruit.
12. To make thorough spraying possible.
13. To facilitate the harvesting of the fruit.

Thinning.—If the fruit is to attain a commercial standard, be of a good quality, attractive appearance, and to eliminate "off" years, thin to four to six inches between each fruit. Thin after the "June drop" or about four to six weeks after the petals fall.

If the leaves curl early in the season, you may have the leaf curl disease among your trees and they should be sprayed with Bordeaux mixture or lime sulphur.

If the leaves turn yellow early in the summer, dig out the tree or cut off any affected branch and burn it. There is no remedy for the peach yellows.

FIG. 76.—The flat-headed borer. *a*, the larva; *b*, the pupa; *d*, the perfect beetle. It injures many kinds of trees.

Quince.—The quince is seldom grown because it is slow to bear and very irregular in growth. It requires a well-drained, clay soil. Secure one- or two-year-old trees, prune off all side shoots and form a standard on which a low head may be formed. Prune out all superfluous shoots each spring before the sap flows and allow the air to circulate freely among the branches. Sucker growth is common and should be cut out. The same treatment of the soil in fertilizers and cultivation which is suited to the culture of the peach is demanded by the quince.

Age of bearing.—Not infrequently amateur fruit growers expect fruit from their trees much sooner after planting than they should, and disappointment is inevitable. The statements that follow concerning the age at which different fruits bear will serve as a general guide. The age of a tree is usually reckoned from the time it is planted in its permanent place.

Apple trees should begin to bear, as a rule, when they have been planted six to eight years. Certain varieties, as the Yellow Transparent and Wagener, may bear considerably younger, and

others, such as the Northern Spy and Yellow Newtown, not until they are somewhat older. Individual trees of the same variety vary somewhat in this respect.

Pear trees bear, in general, at about the same age as apple trees, though perhaps a little younger.

Peach trees under favorable conditions often bear at three years of age, and in any event they should bear at four years unless injured by frost or otherwise.

Plums vary considerably according to the group to which they belong, but most sorts begin to bear in four or five years after planting.

Sour cherries ordinarily begin to bear in about four years and sweet cherries at six or seven years after planting.

Apricots come into bearing at about the same age as peaches, or sometimes a little later.

Quinces are usually five or six years old before they bear much fruit.

Raspberries, blackberries, and dewberries, if planted in the spring, should bear a light crop the next year. Strawberries planted in the spring or early enough in the autumn to make a good growth before the advent of cold weather should produce a good crop the next season.

Currants and gooseberries commonly bear a few fruits the third season after planting.

Grapes may bear very lightly the third season where conditions are favorable, but not much fruit should be expected earlier than the fourth year.

LISTS OF VARIETIES FOR DIFFERENT DISTRICTS

District 1

Varieties marked with an asterisk (*) are of special importance for the colder sections of the district. For an explanation of the abbreviations used in connection with peaches, see under "Peach varieties" (p. 159); under strawberries the abbreviation imp. = imperfect. A synonym is shown by printing the name in italic type in parentheses.

Apples.—Early: Yellow Transparent, *Oldenburg (*Duchess*), Tetofski, Peach (*Peach of Montreal*). Midseason: *Wealthy, *Dudley, Fameuse. Winter: McIntosh, Bethel, *Scott Winter, Tolman (sweet).

Pears.—Flemish (in milder sections), Clapp Favorite (in milder sections).

Peaches.—Planting not advised.

Plums.—Arctic (*Moore Arctic*), De Soto, Forest Garden, Wolf, Cheney.

Cherries.—Richmond, Montmorency.

Raspberries.—Herbert,[1] Ranere (*St. Regis*).[1]

Blackberries.—Snyder.[1]

Dewberries.—Planting not advised.

[1] Hardy in the more favorable parts of this area.

Currants.—Perfection (red), White Imperial.
Gooseberries.—Downing.
Strawberries.—Dunlap, Warfield (imp.), Progressive.
Grapes.—Planting not advised.

District 2

EAST AND WEST AS A WHOLE

The following varieties are suggested for all of district 2, aside from the exception noted:

Apples.—Early: Yellow Transparent, Early Harvest, Oldenburg, Primate, Williams, Jefferis, Benoni, Maiden Blush, Gravenstein. Midseason: Wealthy, Ramsdell (sweet), Fall Pippin, Mother, Hubbardston. Winter: McIntosh, Tompkins King, Tolman (sweet), Rhode Island Greening, White Pippin, Baldwin, Northern Spy.

Pears.—Giffard, Tyson, Bartlett, Seckel, Howell, Bosc, Anjou, Lawrence, Winter Nelis.

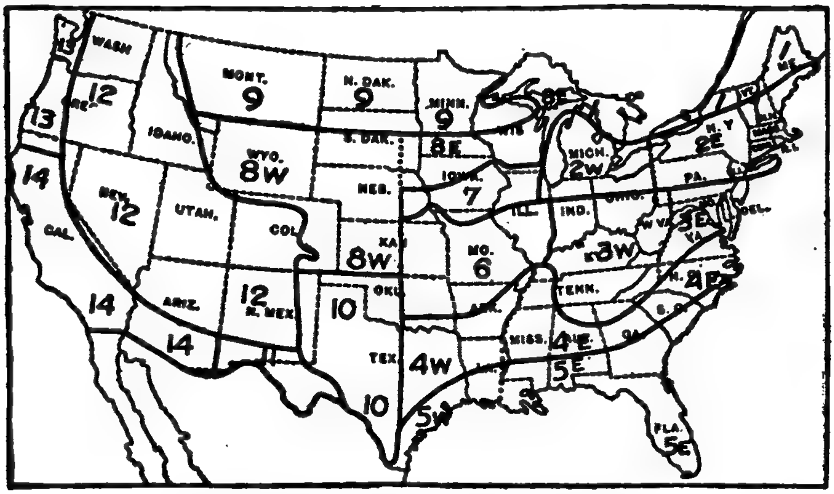

FIG. 17.—Map of the United States, showing the districts into which the country is divided for use in applying the fruit-variety lists.

Peaches.—Greensboro (w fc), Carman (w fc), St. John (y f), Champion (w fc), Reeves (y f), Oldmixon Free (w f), Elberta (y f), Late Crawford (y f), Chairs (y f), Stevens (w f), Smock (y f).

Plums.—Bradshaw, Lombard, Diamond, Reine Claude, Grand Duke, Archduke, Jefferson, Monarch, Middleburg, Italian (prune), Shropshire (damson). Japanese varieties: Red June, Abundance, Burbank, Chabot.

Cherries.—Sour varieties: Richmond, Montmorency, English Morello. Sweet varieties: Tartarian, Spanish, Windsor.

Raspberries.—Cuthbert (red), Golden Queen (yellow), Cumberland (black), Columbian (purple).

Blackberries.—Eldorado (except along northern border in New England), Snyder, Mersereau.

Dewberry.—Lucretia.

Currants.—Perfection (red), White Imperial.

Gooseberry.—Downing.

Strawberries.—Early: Dunlap. Late: Belt (*William Belt*), Sample (imp.).

Grapes.—White: Diamond, Empire State, Niagara, Winchell. Red: Brighton, Brilliant, Delaware, Salem. Black: Concord, Ives, Moore, Worden.

EAST AND WEST SEPARATELY

The following varieties are suggested for district 2, east: *Gooseberry*—Columbus (European); *raspberries*—Herbert, Marlboro (both red), and Farmer (black); *strawberry*—Marshall (early). For district 2, west: *Currant*—London (red); *raspberry*—King (red); *strawberry*—Bubach (imp.).

District 3

EAST AND WEST AS A WHOLE

The following varieties are suggested for all of district 3, aside from the exceptions noted:

Apples.—Early: Yellow Transparent, early Harvest, Early Ripe, Red June, Williams, Benoni, Horse, Maiden Blush, Wealthy. Midseason: Smokehouse, Bonum, Delicious, Grimes, Kinnard. Winter: York Imperial, Rome Beauty, White Pippin, Stayman Winesap, Winesap, Royal Limbertwig.

Pears.—Bartlett (in Pennsylvania, Ohio and Indiana only), Seckel, Kieffer.

Peaches.—Mayflower (w c), Early Wheeler (w c), Greensboro (w fc), Arp, (y c), Carman (w fc), Hiley (w fc), Belle (w fc), Ray (w fc), Reeves (y f), Elberta (y f), Frances (y f), Late Crawford (y f), Chairs (y f), Smock (y f), Levy (y c), Salwey (y f).

Plums.—Native and hybrid varieties: America, Forest Rose, Gonzales, Milton, Miner, Munson, Newman, Poole Pride, Pottawattamie, Robinson, Whitaker, Wildgoose. Japanese varieties: Red June, Abundance, Burbank, Chabot.

Cherries.—Same as for district 2, but with decreasing value southward.

Raspberries.—Cuthbert (red), Golden Queen (yellow), Cumberland (black), Columbian (purple).

Blackberries.—Early Harvest, Eldorado, Evergreen (in New Jersey only).

Dewberry.—Lucretia.

Currants.—Perfection (red), White Imperial.

Gooseberry.—Downing.

Strawberries.—See below.

Grapes.—White: Diamond, Niagara, Winchell. Red: Brighton, Brilliant, Delaware. Black: Concord, Moore, Worden.

EAST AND WEST SEPARATELY

The following varieties are suggested for district 3, east: *Gooseberry*—Columbus (European); *raspberry*—Ranere (red); *strawberries*—Premier (early), Success (early), Joe (late), Chesapeake (late); *grapes*—Elvira (white), Lutie (red), Ives (black). For district 3, west: *Currant*—London (red); *dewberry*—Mayes (*Austin*); *raspberry*—King (red); *strawberries*—Dunlap, Bubach (imp.) (both varieties except in Tennessee and southward), Thompson (in Tennessee and southward), Aroma (throughout section); *grapes*—Martha (white), Catawba (red), Carman (black).

District 4

EAST AND WEST AS A WHOLE

Apples.—Early: Yellow Transparent, Red June, Early Harvest, Red Astrachan, Horse, San Jacinto, Bledsoe. Midseason: Bonum, Kinnard. Winter: Winesap, Texas Red, Yates, Terry.

Pears.—Kieffer (with Le conte or Garber).

Peaches.—Same as for district 3, though the late varieties should probably be omitted.

Plums.—Same as for district 3.

Cherries.—Planting not advised.
Japanese persimmons.—See district 5.
Figs.—See district 5.

EAST SEPARATELY

Raspberry.—Ranere (above 500 feet altitude).
Blackberry.—Early Harvest (above 500 feet altitude).
Dewberry.—Lucretia.
Strawberries.—Klondike, Missionary, Thompson.
Currants and *gooseberries.*—Planting not advised.
Grapes.—White: Diamond, Empire State, Elvira, Niagara. Red: Agawam, Brighton, Brilliant, Delaware. Black: Concord, Carman, Moore, Diamond. Along the Atlantic coast and extending about 100 miles inland the varieties of the Muscadine group of grapes also succeed. These include Thomas, James, Eden, Flowers, Mish and Scuppernong.

WEST SEPARATELY

Blackberries.—Early Harvest, Dallas, McDonald (self-sterile), Haupt.
Dewberry.—Mayes (*Austin*).
Strawberries.—Klondike, Thompson.
Raspberries, currants and *gooseberries.*—Planting not advised.
Grapes.—White: Gold Coin, Wapanuka, Winchell, Rommel. Red: Headlight, Brilliant, Brighton, Last Rose. Black: Husmann, Fern (*Fern Munson*), Moore, Carman.

District 5

EAST AND WEST AS A WHOLE

Apples.—Planting not advised.
Pear.—Kieffer (with Le Conte or Garber).
Peaches.—Jewel (y f), Honey (w f), Imperial (w f), Pallas (w f), Waldo (w f), Florida Gem (w f), Climax (w f), Colon (w f), Triana (w f), Angel (w f), Hall Yellow (y f), Cabler (r c), Estella (y f), Onderdonk (y f).
Plums.—Six Weeks, Excelsior, Terrell, America, Poole Pride. Japanese varieties: Red June, Abundance, Burbank, Kelsey.
Cherries.—Planting not advised.
Japanese persimmons.[1]—Tanenashi, Hachiya, Hyakume, Okame, Triumph, Tamopan, Eureka, Zengi, Costata, Ormond, Gailey,[2] Masugata.[2]
Figs.—Celeste,[3] Turkey[3] (*Brown Turkey*), Brunswick, Ischia, Lemon, Magnolia.[4]

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[1] Comparatively little definite information exists in regard to the range of adaptability of different persimmon varieties. This list includes the principal sorts that are planted in the South Atlantic and Gulf States. Tanenashi is probably grown more extensively at present than any other sort. The Eureka has proved especially hardy and desirable in Erath County, Tex., about sixty miles southwest of Fort Worth, and also at one or two points considerably farther north. The Tamopan is a Chinese variety and may possess a greater degree of hardiness than was formerly supposed. Zengi is one of the earliest varieties. Costata and Ormond may be too late for growing in most parts of district 4.

[2] Gailey and Masugata are not of much value for their fruit, but, unlike the other varieties, the trees have both pollen-bearing and fruit-producing blossoms. As a rule, these two types of blossoms are borne on separate trees. While some varieties produce fruit without pollination, others do not; hence, in planting any large number of persimmons it is advisable to include a pollen-producing sort.

[3] The Celeste is regarded as the hardiest variety of this group, with Turkey perhaps only slightly less hardy. The former is much more widely planted than any of the others in the list. These two sorts should be planted in district 4 in preference to the others, unless possibly in a few especially favorable localities.

[4] The Magnolia is planted in the Gulf coast region of Texas nearly to the exclusion of other varieties. It is not satisfactory in other parts of district 5, except possibly in the southwestern part of Louisiana.

Grapes.—White: Wapanuka, Hidalgo, Niagara, Krause. Red: Brighton, Captivator, Agawam, Valhallah. Black: R. W. Munson, Cloeta, Carman, Champenel. The varieties of the Muscadine group named under district 4, east, are also adapted to most parts of district 5. By adopting special methods of training and by grafting on resistant stocks, certain varieties of Vinifera or European grapes have been grown with some success. However, they are not recommended for general planting in this district.

EAST SEPARATELY

Raspberries, blackberries, dewberries, currants, gooseberries and *strawberries.*—Same as for district 4, east.

WEST SEPARATELY

Raspberries, blackberries, dewberries, currants, gooseberries and *strawberries.*—Same as for district 4, west.

District 6

Apples.—Early: Yellow Transparent, Early Harvest, Red June, Oldenburg, Benoni, Maiden Blush, Wealthy. Midseason: Grimes, Jonathan, King David, Delicious. Winter: York Imperial, Stayman Winesap, Winesap, Ingram.

Pears.—Bartlett, Seckel, Anjou, Kieffer.

Peaches.—Early Wheeler (w c), Greensboro (w fc), Arp (y c), Carman (w fc), Hiley (w fc), Belle (w fc), Family Favorite (w fc), Elberta (y f), Stevens (w f), Stump (w f), Smock (y f).

Plums.—Native and hybrid varieties: De Soto, Miner, Surprise, Terry, Whitaker, Hawkeye, Pottawattamie, Golden (*Gold*), Brittlewood, Emerald. Japanese varieties: Red June, Abundance, Burbank.

Cherries.—Richmond, Montmorency.

Raspberries.—King (red), Pearl (black), Cardinal (purple).

Blackberries.—Mersereau, Eldorado, Early Harvest.

Dewberries.—Lucretia, Mayes (*Austin*).

Currants.—Perfection (red), London (red), White Imperial.

Gooseberries.—Downing, Oregon.

Strawberry.—Dunlap.

Grapes.—White: Winchell, Diamond, Noah, Elvira. Red: Brilliant, Lutie, Catawba, Brighton. Black: Moore, Concord, Worden, Bacchus.

District 7

Apples.—Early: Yellow Transparent, Livland Raspberry, Oldenburg, Charlamoff, Whitney, Benoni, Dyer. Midseason: Wealthy, Brilliant, Patten, Ramsdell (sweet), Roman Stem. Winter: Banana, White Pearmain, Northwestern, Black Annette, Delicious, Tolman (sweet), Windsor, Stayman Winesap, Ralls.

Pears.—Flemish, Bartlett, Seckel, Kieffer.

Peaches are uncertain at the best in this district. In favorable seasons the following varieties would probably fruit in some sections: Greensboro (w fc), Champion (w f), Bailey (w fc), Crosby (y f), Wright (w fc), Russell (w f), Bokhara (w f), Lone Tree (y f).

Plums.—Forest Garden, Stoddard, Wolf, Surprise, Rockford, Hawkeye, Terry, De Soto, Wyant, Miner, Emerald, Brittlewood.

Cherries.—Timme, Richmond, Montmorency.

Raspberries.—King (red), Sunbeam (red), Minnesota No. 4 (red), Older (black), Columbian (purple).

Blackberries.—Eldorado, Snyder.

Dewberries.—Planting not advised.

Currants.—Perfection (red), London (red), White Imperial.

Gooseberries.—Downing, Carrie.

Strawberries.—Dunlap, Warfield (imp.).

Grapes.—White: Diamond, Niagara, Noah, Winchell. Red: Brighton, Catawba, Lutie, Woodruff. Black: Concord, Ives, Moore, Worden.

District 8

EAST AND WEST AS A WHOLE

Apples.—Early: Yellow Transparent, Livland Raspberry, Oldenburg, Iowa Beauty, Benoni. Midseason: Wealthy, McMahan, Anisim, Wolf River, Utter, Peerless, Plumb, Cider. Winter: McIntosh, Patten, Northwestern, Jewell Winter, Milwaukee, Scott Winter, Malinda.

Pears.—Flemish, Warner.

Peaches.—Planting not advised.

Plums.—De Soto, Forest Garden, Cheney, Wolf, Wyant, Stoddard, Surprise, Rollingstone, Waneta. Sand cherry-plum hybrids: Compass, Hanska, Sapa, Opata, Sansota, Cheresota, Wachampa.

Cherries.—Timme, Richmond, Montmorency.

EAST SEPARATELY

Raspberries, blackberries, dewberries, currants, gooseberries and *strawberries.*—Same as for district 7, except that the Columbian raspberry should be omitted.

Grapes.—White: Diamond, Niagara, Noah, Winchell. Red: Brilliant, Delaware, Merrimac, Woodruff. Black: Concord, Ives, Moore, Worden.

WEST SEPARATELY

The same varieties of currants and gooseberries are suggested as for district 7. On account of limited precipitation, raspberries, blackberries and strawberries are not likley to be very satisfactory in district 8, west, except under irrigation. If water can be applied, and perhaps winter proection given, the same varieties as those suggested for district 7 may prove of some value. Conditions are similar with reference to grapes. No varieties can be recommended for this section with confidence of success, but where irrigation and winter protection can be given the following may be worth trying: White—Diamond, Lady, Martha, Niagara; red—Agawam, Catawba, Delaware, Vergennes; black—Concord, Hartford, Isabella, Worden.

District 9

Apples.—Oldenburg (*Duchess*), Patten, Okabena, Hibernal.

Pears.—Planting not advised.

Peaches.—Planting not advised.

Plums.—The list for district 8 contains the varieties of most importance for district 9, The sand cherry-plum hybrids are also of value in many sections of district 9.

Cherries.—The varieties named for other districts are not likely to be hardy, as a rule, in this district. Sand cherries, however, are of value for jellies, etc. Buffalo berries and other native wild fruits are also used for jelly-making.

Currants.—Perfection (red), London (red), White Imperial.

Gooseberries.—Downing, Carrie.

Strawberries.—With winter protection: Dunlap, Warfield (imp.), Progressive.

Respberries, blackberries, and *dewberries.*—Planting not advised.

Grapes.—The conditions are not well adapted to grape growing, and only the very hardy sorts are likely to succeed even in the more favorable locations. The ones suggested for trial are Alaska, Beta No. 1, Beta No. 2, Beta No. 3, Bicolor, Dakota, and Janesville.

District 10

Apples.—Early: Yellow Transparent, Red June, San Jacinto, Maiden Blush, Gravenstein, Wealthy. Midseason: Grimes, Jonathan, Kinnard. Winter: Northwestern, Texas Red, Winesap, Missouri, Arkansas Black, Ralls, Limbertwig.

Pears.—Bartlett, Seckel, Kieffer.

Peaches.—Alexander (w c), Sneed (w c), Triumph (y c), Arp (y c), Carman (w fc), Mamie Ross (w fc), Chinese Cling (w c), Elberta (y f), Lee (*General Lee*) (w c), Krummel (y f), Heath (w c).

Plums.—Six Weeks, De Soto, Golden (*Gold*), America, Hammer, Poole Pride, Pottawattamie, Laire, Robinson, Wayland, Whitaker, Wildgoose, Wolf, Wooten.

Cherries.—Richmond, Montmorency.

Raspberries.—Of doubtful value.

Blackberries.—Crandall, Early Harvest.

Dewberry.—Mayes (*Austin*).

Strawberries.—Klondike, Arizona, Michael.

Blackberries, dewberries, and strawberries are likely to fail in district 10 without irrigation, on account of limited precipitation.

Currants and *gooseberries.*—The same varieties listed for district 7 are suggested for trial in district 10.

Grapes.—White: Hidalgo, Krause, Rommel, Wapanuka. Red: Captivator, Ellen Scott, Headlight, Marguerite. Black: Bailey, Champenel, Fern, Husmann.

District 11

Apples.—Early: Yellow Transparent, Early Harvest, Red June, Maiden Blush. Midseason: Wealthy, Grimes, Jonathan, Delicious. Winter: Winesap, Missouri, Rome Beauty, Arkansas Black, White Pearmain.

Pears.—Bartlett, Seckel, Kieffer.

Peaches.—Alexander (w c), Triumph (y c), Greensboro (w fc), Carman (w fc), Ray (w fc), Texas (*Texas King*) (w fc), Mamie Ross (w fc), Belle (w fc), Elberta (y f), Late Crawford (y f), Crothers (w fc), Krummel (y f), Salwey (y f).

Plums and *cherries.*—Very few grown. Probably the varieties suggested for district 10 would furnish satisfactory supplies for home use.

Little information exists concerning the adaptability of bush-fruit varieties to this district.

Raspberries.—Of rather doubtful value.

Blackberries, dewberries, and *strawberries.*—The varieties named for district 10 are suggested for district 11.

Currants and *gooseberries.*—The varieties named for district 12 are suggested for trial in district 11.

Grapes.—No very definite suggestions are possible with reference to varieties. In some places along the Pecos river and the Rio Grande a few Old World varieties are grown, of which the Mission is the principal one. Sultanina, Sultana, Muscat, Alexander, and Black Hamburg might succeed, but all of these varieties should probably have winter protection.

District 12

Apples.—Early: Yellow Transparent, Red June, Red Astrachan, Early Harvest, Gravenstein. Midseason: Grimes, Jonathan, Ortley, Wagener. Winter: Delicious, Rome Beauty, Banana, Stayman Winesap, Winesap, White Pearmain, Arkansas (*Mammoth Black Twig*), Arkansas Black.

In some of the irrigated valleys in Washington the Esopus and Yellow Newtown are also grown but they do not occur as widely as most of the varieties named in the above list. The McIntosh is one of the most important varieties in the Bitter Root Valley in Montana.

Pears.—Bartlett, Flemish, Anjou, Winter Nelis.

Peaches.—Alexander (w c), Early Hale (w fc), Early Crawford (y f), Elberta (y f), Muir (y f), Late Crawford (y f), Lovell (y f).

Plums.—Japanese varieties: Red June, Abundance, Burbank, Wickson, Satsuma. European varieties: Bradshaw, Lombard, Reine Claude (*Green Gage*), Peach, Columbia, Washington, Yellow Egg, Pond.

Prunes.—Italian, Silver, Agen (French), Hungarian, German, Tragedy.

Cherries.—Sour varieties: Richmond, Montmorency. Sweet varieties: Tartarian, Bing, Napoleon (*Royal Ann*), Republican, Lambert.

Apricots.—Moorpark, Blenheim, Royal, Tilton. Apricots habitually blossom very early in the spring; hence the blossoms are often killed by frosts except in very favorable localities.

Raspberries.—Marlboro, Cuthbert.

Blackberries.—Eldorado, Lawton, Snyder, Logan (in the milder valleys of Idaho, Oregon, and Washington).

Dewberry.—Lucretia.

Currants.—Perfection (red), White Imperial.

Gooseberries.—Oregon, Poorman.

Strawberries.—Dunlap, Jucunda (in Colorado and Utah), Clark, Superb.

Grapes.—In the milder portions of district 12, especially in the southern part, some of the Vinifera, or Old World, varieties may be grown, the Sultanina being the favorite one. In some parts of Idaho and Oregon, with winter protection, the more hardy varieties of the Old World grapes have given fairly good results. These include such sorts as the Black Hamburg, Chasselas de Fontainbleau, Flame Tokay, Jura Muscat, Sylvaner, and Zinfandel. American varieties suggested for trial planting in this district are Diamond, Niagara, Winchell, Brighton, Delaware, Concord, Isabella, and Worden.

District 13

Apples.—Most of the varieties in the list for district 12 occur widely in district 13. However, in the Puget Sound region such varieties as Alexander, Tompkins King, McIntosh, Rhode Island Greening, Baldwin, and Northern Spy, together with Gravenstein and Wagener of the list named for district 12, are relatively the most important sorts. Most of the above-named sorts also are grown to a limited extent in other parts of district 13 as well as at the lower altitudes in the eastern part of Oregon.

Pears.—Bartlett, Howell, Bosc, Anjou, Comice, Winter Nelis,

Peaches, plums, prunes, apricots, and *cherries.*—Substantially the same as for district 12.

Raspberries.—Cuthbert (red), Antwerp (red), Golden Queen (yellow).

Blackberries.—Eldorado, Snyder, Evergreen, Logan.

Dewberries.—Lucretia, Gardenia.

Currants.—Perfection (red), White Imperial.

Gooseberry.—Oregon.

Strawberries.—Gold Dollar (early), Marshall, Magoun, Oregon, Clark (for canning), Superb.

Grapes.—Conditions in western Washington are not favorable for grape growing. In western Oregon the same varieties suggested for district 12 may be grown without winter protection.

District 14

Apples.—While there is considerable difference in the adaptability of varieties to the different sections of California, those named in the list for district 12 have a wide range of adaptability and comprise the most important ones grown in district 14, aside from the Yellow Bellflower and Yellow Newtown, which are grown largely in the Pajaro Valley, and the Gravenstein, which is produced in large quantities about Sebastopol, in Sonoma County. These three varieties make up a large proportion of the commercial apple industry of California.

Pears.—Bartlett, Howell, Bosc, Anjou, Comice, Winter Nelis.

Peaches.—Alexander (w c), Triumph (y fc), Early Hale (w fc), Early Crawford (y f), Tuskena[1] (y c), Foster (y c), Decker (w f), Elberta (y f), Muir[2] (y f), McKevitt (w c), Late Crawford (y f), Lovell[2] (y f), Phillips[1] (y c), Salwey (y f).

Plums.—Yellow Egg, Washington, Jefferson, Grand Duke, Climax, Clyman, Wickson, Kelsey, Burbank, Satsuma.

Prunes.—Agen (French), Sugar, Imperial, Sergeant (*Robe de Sergeant*), Silver.

Cherries.—Chapman, Tartarian[3], Napoleon (*Royal Ann*), Big, Republican[3], Lambert.

Apricots.—Moorpark, Blenheim, Hemskirk, Royal, Tilton.

Figs.—Adriatic, Ischia, Mission, Marsellaise, Smyrna type[4].

Japanese persimmons.—Goshio, Hachya, Hyakume, Tanenashi, Yemon.

Raspberries.—Cuthbert (northern California), Surprise (southern California).

Blackberries.—Mammoth (self-sterile), Logan, Himalaya, Lawton (northern California), Crandall (southern California and Arizona).

Dewberry.—Gardenia.

Currant.—Perfection (northern coast section).

Gooseberry.—Oregon (northern coast section).

Strawberries.—Marshall (Fresno and northward), Oregon (Fresno and northward), Brandywine (southern California only), Arizona (in Arizona).

Grapes.—In this district the Vinifera, or Old World, varieties are grown nearly to the exclusion of American sorts. On account of the destructiveness of the phylloxera it is necessary to propagate the vines on stocks or roots that are resistant to that insect except in the case of the "direct producers," which are themselves resistant to the phylloxera.

The following varieties are named for district 14, and especially for California northward from a region somewhat south of Los Angeles: White—Alexandria, Green Hungarian, Palomino, Sultanina; red—Aramon, Flame Tokay, Barbarossa, Chasselas de Fontainbleau; black—Bellino, Gross Colman, Muscat Hamburg, Zinfandel.

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[1] Used largely for canning.

[2] Though used for canning and for shipping fresh, Muir and Lovell are of importance largely for drying.

[3] See comment on page 00 concerning the self-sterility and intersterility of sweet cherry varieties.

[4] Several varieties of figs of the Smyrna type are grown in district 14. In parts of California they are being planted on a large commercial scale. Perhaps the Lob Ingir variety is one of the most important. Smyrna figs require caprification in order to develop fruit; hence, caprifig trees must be planted with Smyrna figs. The amateur grower not otherwise informed should seek further advice before planting figs of this type.

CHAPTER IX

BUSH FRUITS AND STRAWBERRIES

Blackberry.—The blackberry is becoming more popular every year, but in many farms it is allowed to grow wild and produce inferior berries.

Location.—The canes should be planted where there is considerable moisture during the growing and ripening season. Never plant where there is standing water in winter. The location should be sheltered, protected from late frost and with good air drainage.

Soil.—Deep sandy loam with considerable humus in it. The soil should be deep and capable of holding moisture. Plow sod land in the fall. If the subsoil is more or less stiff, subsoil plowing is highly recommended.

Planting.—Plant early in the spring. Set slightly deeper than planted in the nursery. Remove all bruised roots and cut the top back to five to seven inches. Rows eight feet apart and plants four feet in the rows, 1,361 plants per acre.

Fertilizing.—The blackberry is a gross feeder and should have from fifteen to twenty tons of stable manure per acre. Coarse bone meal mixed with the manure will add the needed plant food, but commercial fertilizers are not usually recommended. Leguminous crops such as cowpeas, clover, etc., if plowed under each spring, will add the necessary plant food, as well as humus.

Cultivation.—Cultivate early in the spring, as soon as the soil is fit to work. Surface cultivation should be frequent. Keep down all suckers and weeds. Keep a dust mulch over the surface. Cultivate shallow, and discontinue at least one month before freezing, and apply the mulch of manure.

Results of Different Degrees of Cultivation

Treatment	Farms	Acres	Average Quarts per Acre	Average Income per Acre
Intensive cultivation	9	14.65	1,890.64	$244.65
Plowing plus cultivation	8	14.83	1,766.55	153.46
Moderate cultivation	5	2.58	1,032.55	92.45

N. Y. State Coll. of Agriculture

Training.— There are many practical methods of training, and they vary according to the conditions under which the blackberry is grown. One thing is certain — the canes should never be allowed to run wild. Cut out all old growths close to the surface of the crown. Pull suckers and keep the plant to from three to four vigorous canes. These may be pruned back before the buds start to form, three to four feet from the crown. A few of the systems of training are here shown in Figures 78, 79, 80, 81 and 82, as suggested by the U. S. Department of Agriculture.

FIG. 78.—Blackberry canes of the upright type tied to two wires, one placed above the other.—*U. S. Dept. of Agriculture.*

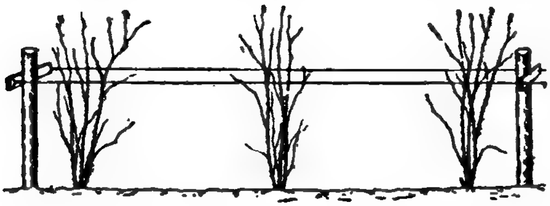

FIG. 79.—Blackberry canes of the upright type held between two wires.—*U. S. Dept. of Agriculture.*

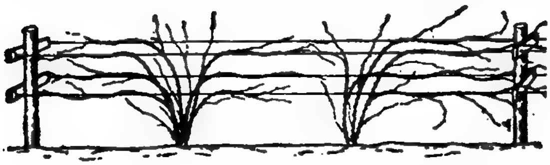

FIG. 80.—Blackberry canes of the trailing type trained along four wires.—*U. S. Dept. of Agriculture.*

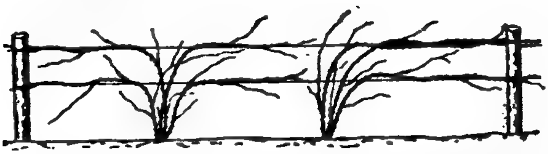

FIG. 81.—Blackberry canes of the trailing type trained along two wires.—*U. S. Dept. of Agriculture.*

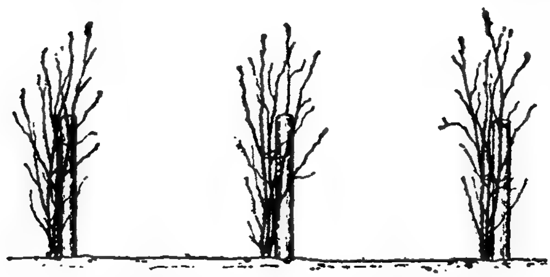

FIG. 82.—Blackberry canes of the upright type tied to posts.—*U. S. Dept. of Agriculture.*

New plants may be secured by digging up a sucker with part of the root system attached, and transplanting. Root cuttings three to four inches long and one-quarter inch in diameter, taken in the fall or early spring, will develop satisfactory plants. The plantation should be re-established about every six to seven years.

Winter protection.— Where the canes are injured by very severe frosts, they should be bent over in the fall

and covered with soil or some litter. This should be done after the canes become dormant. Uncover early in the spring.

Raspberry.—There are three types of raspberries — the red, having upright canes and producing red berries; the black, arched canes having black berries; and the purple, arched canes, producing purple berries.

Location.—A cool climate is most desirable, and good air, drainage, and a sufficient supply of moisture are very necessary. Better on a hillside than on level land.

Soil.—A deep, sandy loam with considerable humus incorporated is considered the best, but some of the varieties do well on a clay loam. Soil should be plowed deeply and the surface soil well harrowed. Wherever a root crop may be grown the year before planting the canes, it is recommended. The weeds are destroyed and the land is in a better state of fertility.

Planting.— In the east the plants are set in the spring, and should be planted so as to receive the benefits of the early rains. The red varieties, if planted in the fall under favorable conditions, will be well established by late spring. If planted in the hill system and staked, set the plants five feet apart each way, 1,742 plants per acre. If the hedge system is used, rows should be six feet apart, with plants three feet apart in the rows, 2,420 plants per acre. Black raspberries grown under the linear system (no suckers allowed to grow), the rows are eight feet apart, with the plants four feet apart in the rows, and 1,361 plants per acre. For the red varieties, plant three inches deeper than nursery planting. For the black and purple varieties, plant two inches deeper. On planting, cut the canes back to five to six inches. Pack the soil firmly about the roots.

Fertilizers.—The soil should be in a high state of fertility before planting. Annual application of five to ten tons of stable manure per acre, depending on the fertility of the soil, will be sufficient. Cover crops, plowed under in the spring, are most desirable. Do not plant the seed among the canes, especially of crops that live over winter.

Cultivation.—A thorough tillage is necessary to keep down all grass and weeds. A dust mulch should be formed in order to conserve moisture. Cultivate the surface soil during the harvest period if the season is dry. Avoid late tillage.

Pruning and training.—The manner of growth has much to do with the method of training, and, like the blackberry, the canes should never be allowed to run wild. As soon as berries ripen the canes die. Cut out all dead wood. The red raspberry sends

up suckers; the black and purple ones do not. The red raspberries are therefore pruned and trained differently from the black or purple varieties. Red raspberries are frequently raised

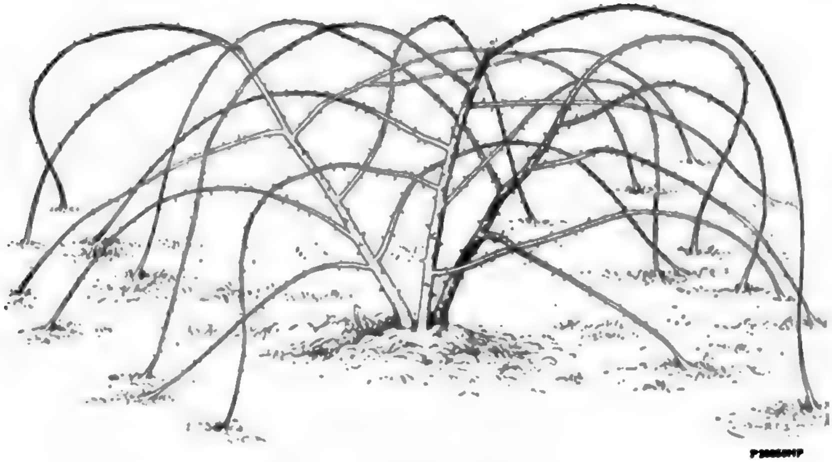

FIG. 83.—A black raspberry plant with the laterals rooting at the tips.—*U. S. Dept. of Agriculture.*

under the hill system. The canes are tied to a stake, five to seven canes per plant. Pruning back of the tips is seldom needed.

The hedge system is very common. The canes are allowed to grow in a hedge row, the surface between the rows being kept cultivated. Often wire supports are placed so as to hold the canes in position. The canes under the hedge system should never be allowed to crowd.

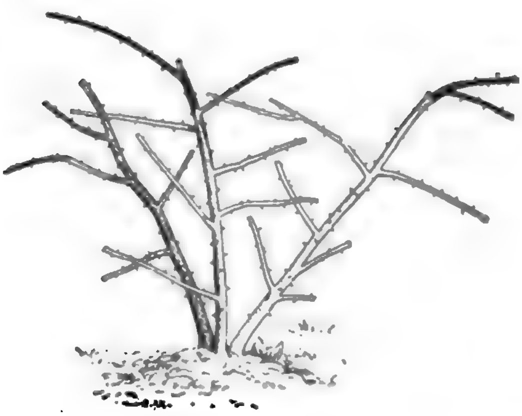

FIG. 84.—The black raspberry plant shown in Fig. 83, after it had been pruned.—*U. S. Dept. of Agriculture.*

With the linear system, all the suckers are cut out. Tall cane varieties may be pruned back to four feet before the buds start. The canes may be held erect by trellises. The plants should never crowd. Practically all of the black and purple raspberries are planted according to the linear system. Young canes should be topped. Black raspberries should be cut back to from eighteen to thirty

inches. Topping the canes is usually done before picking, or when the young canes reach the desired height in the spring. The current season's growth bears the fruit.

The winter protection is similar to that suggested for the blackberry where the winters are very severe. The duration of the plantation varies from six to fifteen years for the red varieties, and from five to eight for the black and purple varieties.

Blackberry and Raspberry

Insects	Control	Remarks
Cane-borer	Cut off drooping tips and burn	Tip girdled by ring of punctures
Saw-fly	Spray with arsenate of lead, 2 lbs. to 50 gals. water (paste). Powdered hellebore, dilute 5 to 10 times with air-slaked lime	Feeds on tender leaves in spring

Blackberry and Raspberry

Diseases	Control	Remarks
Wilt	Set out only healthy plants. Destroy diseased plants by burning	Both red and black varieties of canes wilt and dry
Anthracnose	Spray, Bordeaux mixture, 4-4-50, clean cultivation	Apply when new canes are 6 to 8 inches high. Gray, scab-like spots on canes
Crown gall	Set healthy plants. Burn infected plants	Large knots on root
Red rust	Dig up infected plants and burn	Do not plant on same ground for several years. Red rust streaks on canes

Currant and gooseberry.—The currant is one of the oldest of the small fruits recorded in history and thrives best in a cool, moist climate, while the gooseberry will stand more heat, and both of these bush fruits will withstand low temperatures.

If the white pine is grown commercially in your district, the

law requires that both the currant and gooseberry be eliminated from your garden.

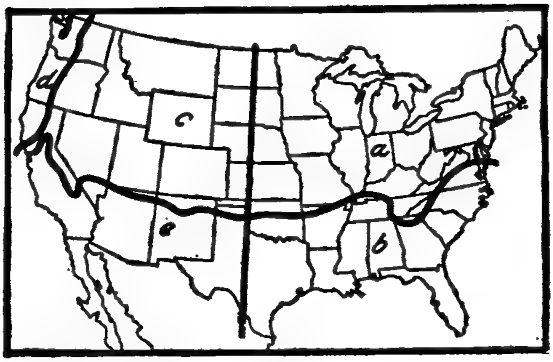

FIG. 85.—Map of the United States, showing the regions where currants and gooseberries may be grown. The area marked *a* is naturally best adapted to currants and gooseberries; in *b* the summers are too long and too hot for these fruits; in *c* low rainfall limits their culture except under irrigation, though these fruits are planted in many dry-land fruit gardens throughout this region. Although the area marked *d* has sufficient rainfall for these fruits, most of the rain occurs during the winter months and the moisture must be carefully conserved, while *e* is both too dry and too hot in summer. The boundaries of these areas are not sharply defined, but grade imperceptibly into each other.—*U. S. Dept. of Agriculture.*

Location.—In the south the northern or northeastern slope is considered best. In the north the plants should be protected from the winds. Do not plant where there is continual dampness; have a free circulation of air.

Soil.—The best type of soil is a deep garden loam richly incorporated with humus. Sod land should be prepared in the fall.

Planting.—Before setting the plants, cut off all broken roots and cut the top back to about ten inches from the crown. Plant one to two inches deeper than where propagated. For horse tillage the rows should be six feet apart. The plants may be set from

FIG. 86.—A black currant bush before pruning.—*U. S. Dept. of Agriculture.*

FIG. 87.—The black currant bush shown in Fig. 86 after pruning. The canes left are all one to two years old.—*U. S. Dept. of Agriculture.*

four to five feet apart in the rows depending on the varieties. Currants and gooseberries may be planted between apple, peach, or pear trees, or grape vines. A little shade is not objectionable.

Fertilizers.—If from ten to fifteen tons of stable manure are worked into the soil each year, no commercial fertilizer will be needed. A green manure is also highly recommended. Apply the manure in the fall. Do not pile it up around the crown. Spread it out evenly over the surface soil. There is no "best" commercial fertilizer recommended.

Pruning.— Cut back vigorously the first year (red and white currants). Fruit is borne on one-year-old wood and on the spurs of two- to three-year-old wood. Prune out three-year-old wood and let the young wood have room to develop. Prune so that the branches are arranged to prevent the soiling of the fruit during heavy rains.

FIG. 88.—Larvae of currant worm, green dotted with black spots.

Black currants.—Remove all wood that has borne two years. One-year-old wood is the best for bearing.

Gooseberries.— Prune similar to the black currant. One-year-old wood and one-year-old spurs bear the best fruit. Remove branches lying close to the ground.

Cultivation.—Cultivate early in the spring, working the manure into the soil. Shallow cultivation is best. Keep free from weeds and grasses.

It is generally recommended that plants be bought from a reliable nurseryman, but cuttings may be made. If cuttings are made especially of the currant, one-year-old wood should be used from six to eight inches long. Store in a box of moist sand in a cool cellar until spring, and plant out in rows, plants three to five inches apart. After the root system is well formed, plant into the permanent place. Fall planting is generally recommended.

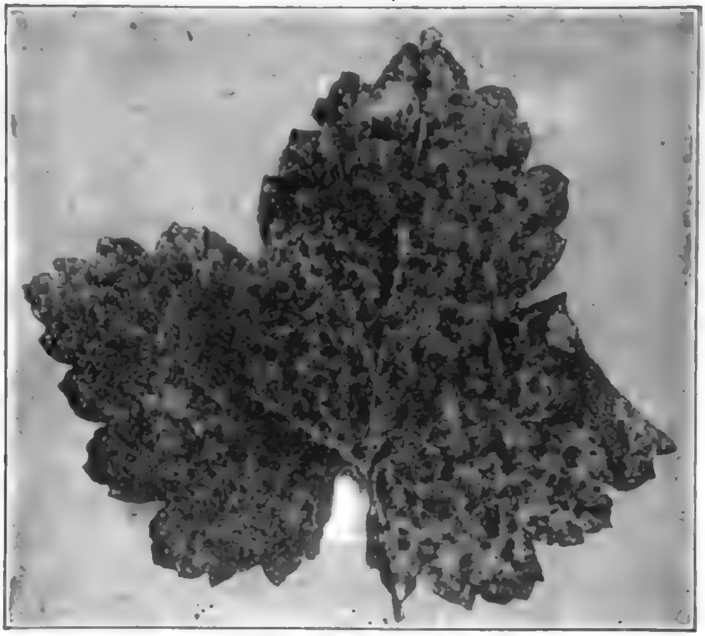

FIG. 89.—A spot disease of currant leaf.—*After Ball.*

CURRANT AND GOOSEBERRY

INSECTS	CONTROL	REMARKS
San José Scale	1 gal. lime sulphur to 8 gals. water	Spray when dormant
Currant worm	Arsenate of lead, 1 lb. powder (2 lbs. paste) to 50 gals. water 1 oz. hellebore to 1 gal. water	Both currants and gooseberries. Spray when worm first appears. Second brood
Aphis	1 oz. nicotine to 8 gals. water Whale oil soap	Examine under foliage for insect. Spray before foliage curls
Yellow currant fly	Fall fallowing recommended	Stings fruit of both currants and gooseberries.

CURRANT AND GOOSEBERRY

DISEASES	CONTROL	REMARKS
Cane wilt	Cut out and burn diseased wood. Spray, Bordeaux mixture	The dormant spray 1–8 lime sulphur is recommended
Leaf spot	Dormant spray. Lime sulphur 1–10. Bordeaux mixture, summer spray	Defoliates plant. Both currant and gooseberries
Anthracnose	Same as leaf spot	Defoliates plant before fruit is ripened. Seldom on the gooseberry
Powdery mildew	1½ gals. lime sulphur to 50 gals. water, summer spray. Repeat at intervals of 10–14 days	Both currants and gooseberries. Spray as soon as buds open

STRAWBERRIES

Strawberries.—There is no small fruit that will bring more delight to the grower than the strawberry. It requires little space and if properly raised will pay well for the soil occupied.

This favorite of all small fruits will thrive in various kinds of soil. It may be found in a sandy loam to a clay loam bearing finely flavored berries. The success or failure in the culture of the strawberry depends not so much upon the soil as upon the plant food available, the moisture, and the method of culture.

All soil, no matter whether it is sandy or a elay formation, must have a large amount of decaying vegetable matter in it. This will aid in retaining the necessary moisture to mature the crop as well as in giving the root system a free feeding surface. While the decaying vegetable matter does increase the activity of ferments and puts plant food in a condition in which the growing plant may use it, care should be exercised not to add too much nitrogen in the form of nitrate of soda, which will cause the plant to develop foliage and not fruit.

If the soil is a sandy loam that has been used for other crops for one or more years, add two or three inches of straw manure (horse or cow) and plow or spade this under in the spring. The manure should be well decayed and incorporated into the soil so as to prevent the leaking out of both water and liquid manure.

The strawberry plants should be set as early as possible in order to get the benefit of the early spring rains.

If the soil is a clay loam, and in sod, add a heavy application of manure and turn the sod under in the fall. Leave the furrows in the rough over winter so that the frost and air may not only hasten the decay of the vegetable matter and loosen the soil, but destroy grubs and other enemies that are exposed. It is not a good practice to plant strawberries on freshly plowed sod land. Add a sprinkling of manure over the surface of the soil in the spring and work it into the first three inches. A sprinkling of bone meal along the row where the plants are to be set will add one of the most valuable of plant foods to the strawberry. If the soil has a tendency to be sour, shown by the growth of the bitter weed or sorrel, a little lime may be added to the soil in the fall. Both lime and land plaster are very objectionable in the strawberry bed after the plants are set.

It is difficult to recommend any special commercial fertilizer or combination because of the great variations in the availability of plant foods in different soils. On the other hand, a combination of phosphoric acid, potash and nitrogen, or each separately, has been applied to certain soils with good results. The application of commercial fertilizers is a local problem and must be solved by the grower.

All land must be naturally or artificially drained from one and one-half to two feet in depth. The strawberry will not survive a year in wet soil. After this first and one of the most important conditions necessary, drainage, is looked after, by preparing the soil so that it is made as fine as a seed bed for six inches in depth. Level culture is preferable to ridging the rows. The soil is more easily worked and there is less danger of the plants wilting during a dry season.

In order to make a good start at the very beginning, secure the best plants possible from a reliable firm.

The best time to plant is early in the spring after the frosts are out of the ground. There is always sufficient rain to sustain the plant until it becomes established. On the other hand, if berries are desired the year after planting and you have failed to complete your plans in the spring, set the plants in August, supply the much-needed moisture at that season and protect the plants during the winter and you will have berries the following June. In the South, where the winters are mild and the soil is a sandy loam, fall planting is very satisfactory.

On receiving the plants from the nursery, remove the damp

moss, cut the band that holds the bunch of twenty-five or fifty plants together, make a furrow and spread the plants out in it. Cover the roots with soil up to the crown. The air circulating soon dries the foliage, which prevents disease, and the plants retain their freshness until their permanent home is ready.

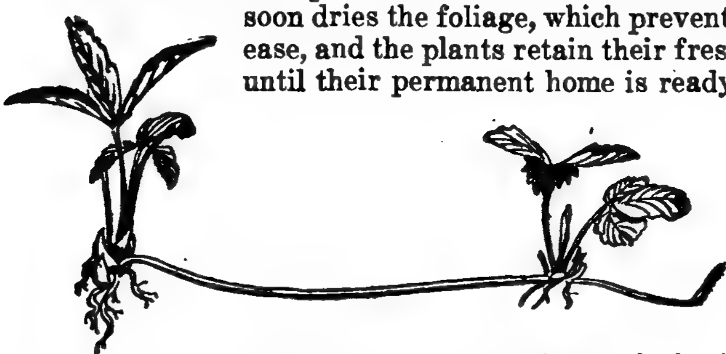

FIG. 90.—A strawberry plant, showing a runner that has developed a new plant.—*After Leubert.*

The distance of planting depends to a large extent on the method of cultivation used. If the solid or matted row method

FIG. 91.—Strawberry plants set at different depths in the soil. At the left is shown a plant set too deep, which will be likely to smother and die; in the center is one set at the proper depth and at the right is a plant set too shallow, which will dry out.—*U. S. Dept. of Agriculture.*

is practiced and a horse cultivator is used between the rows they should be from three to three and one-half feet apart. If the hand cultivator is used the rows may be two feet apart. For especially fine, large berries, the single plant in a place or hill, all runners kept cut off, will be the best method of planting. The

rows should be two feet apart, with the plants fifteen inches apart in the row. The berries grown in this way are usually more perfect, easier to pick, and the plants are healthier on account of having more air and sunshine. The strength of the plant is not allowed to go to runners and in this way there is a more vigorous growth.

The double-matted row is formed by placing the rows three and one-half to four feet apart and the plants two feet apart in the rows. One or two runners are layered in direct line with the parent plant in the row, and two sets of runners are layered on each side of the parent plant. With this method the row soon becomes matted. All extra runners should be cut off and the space between the rows kept cultivated.

STRAWBERRY PLANTS PER ACRE WITH DIFFERENT SPACINGS

DISTANCE APART	PLANTS TO ACRE	DISTANCE APART	PLANTS TO ACRE
2 feet by 1 foot	21,780	2½ feet by 1½ feet	11,616
2 feet by 1½ feet	14,520	3 feet by 2 feet	7,260
3 feet by 1 foot	14,520	3 feet by 3 feet	4,840
3½ feet by 1 foot	12,446	3 feet by 4 feet	3,630

U. S. Dept. of Agriculture

Before setting the plants remove all poorly colored or broken leaves from the outer and lower edge of the crown and prune off some of the roots if they are very long. Set the root system so it is free and not wadded in a ball. All the roots and the lower part of the crown should be in the soil and care should be exercised to keep the heart and upperpart of the crown above the soil.

The first season, if the plants are set in the spring, remove all bloom and start cultivating shortly after the plants are set. Cultivate after a rain, but not when the soil sticks to the implement. No practice is so valuable to the growth and production of the strawberry as frequent and thorough cultivation.

The bisexual (B) varieties have both the male and female organs in the flower, and are therefore self-pollinated, while the female flower, having only the female organs, if not pollinated, will not bear fruit.

The following list of standard varieties is recommended. From one hundred and seventy-five to two hundred plants will supply a family of six with berries through the season:

VARIETIES		NO. OF PLANTS
Extra Early		
Early Ozark	(B)	25
Early		
Dr. Barrel	(B)	25
Clyde	(B)	25
Medium		
Wm. Belt	(B)	25
Bubach	(B)	25
Late		
Brandywine	(B)	50
Gandy	(B)	25
Everbearers		
Superb	(B)	25
Peerless	(B)	25
Americans	(B)	25

It should be remembered that varieties adaptable to one section of the country might be a complete failure in another.

Water is necessary to mature a crop; it is definitely known that it takes six hundred barrels per acre to mature a crop after the fruit is set. Seventy-five per cent of the weight of the green plant is water; therefore, never let the strawberry plant suffer from the lack of sufficient moisture. Evening is the best time to water the plants and get the moisture to the roots. Sprinkling the surface of the soil means nothing. All during the night the moisture will work into the soil and the following morning the cultivator should be kept busy forming a dust mulch to hold the water in the soil.

As the berries are forming, stop cultivating, because any dust is liable to deform the fruit. Place clean straw, hay, leaves or other litter under the fruit to keep it clean, also to act as a mulch. After the berries have been picked, remove the mulch and continue to cultivate. Do not let the strawberry bed become weedy just because the bearing season is over.

The winter mulch of straw or light manure should be placed over the plants after they are fully ripened and after the first two or three light frosts. Early in the spring after the severe frosts have passed, remove the mulch and start cultivating. It is generally advisable to start a new bed every three years, but an old bed may be kept in bearing if properly fed and protected.

The first year such crops as dwarf sweet corn, radish, or spinach may be grown between the rows.

The ever-bearing varieties are planted and treated in the same way as the spring-bearing sorts with one exception, that the

bloom is kept picked off until about July 1st. These ever-bearing sorts seem to be very handy, can stand some drought and excessive heat, as well as wet weather and severe frosts.

The three essentials that should never be overlooked before going into the culture of strawberries are, first, the best variety of strong, vigorous, pure bred plants suited to the soil; second, a well-drained and prepared soil; and third, thorough and frequent cultivation.

INSECTS

INSECTS	CONTROL	REMARKS
White grub	Full plowing before planting	Eats roots

DISEASES

DISEASES	CONTROL	REMARKS
Leaf spot	Spray after growth begins. Bordeaux 5-5-50 Eliminate diseased beds	Deep purple spots, become gray. Spray 3-4 times during season

CHAPTER X

VINE FRUITS

Grapes.—The farmer's garden is hardly complete without a few of the best grapes which may be grown in the open or close to the house. This may not be an ideal site, and the soil may not be a perfect type, but the vines produce. There are also farmers who produce grapes successfully on a commercial scale.

Location.—Where the grape is grown commercially, the vineyards are located near large bodies of water, where the temperature is more or less equalized. Air drainage is very important, and many of the vineyards are on the side hills.

Soil.—There are many types of soil in which the grape is grown successfully. A loam more or less sandy, warm, well-drained and pliable is ideal. The subsoil should be porous. A heavy clay soil should be avoided. The soil should be moderately rich and incorporated with humus. A clean cultivation is desired to free the soil of weeds and grass before planting.

Planting.—Early spring planting is generally recommended, especially for the north. Vines of one year's growth, healthy, free from insects and disease should be planted. Commercial vineyards are planted eight by eight feet, 680 vines per acre, or ten by ten feet, 435 vines per acre. Have the rows straight. Interplant varieties that have imperfect flowers. Prune back the roots a little, so that they are not crowded in the hole, and cut the top back to three to four buds at the time of planting. A finely pulverized, rich soil should be packed firmly about the roots.

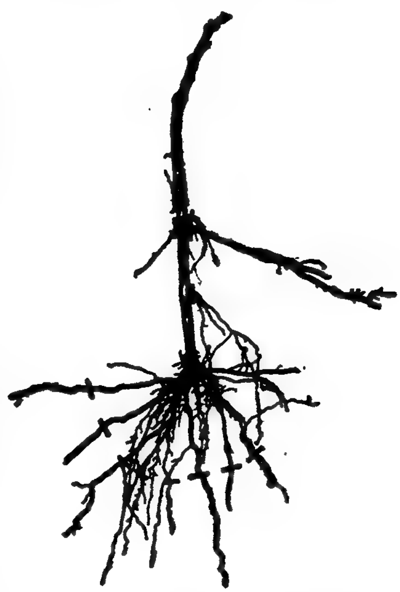

FIG. 92.—A grapevine showing the method of pruning roots ready for planting.—*U. S. Dept. of Agriculture.*

If only a few vines are to be planted close to the house where the soil is usually filled in and very poor, dig holes four feet

square and three feet deep. Loosen up the subsoil. Whenever possible, secure old plaster from a house that is being torn down, mix one-fourth part plaster with one-half part of garden loam and decayed sod, and one-fourth part of bone meal and decayed manure. Mix these and fill the hole to within one and one-half feet of the surface. Fill the remaining space with garden loam and decayed sod.

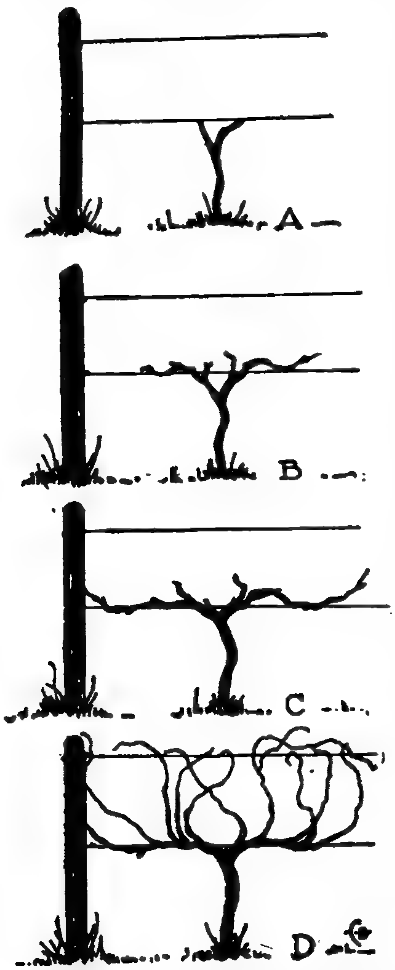

FIG. 93.—A pruned and unpruned vine of different ages, showing the method of pruning by the renewal system. A, second year; B, third year; C, fourth year; D, an unpruned vine in its fourth year.

Plant the vine in the prepared hole early in the spring. Train to a trellis at least one foot from the wall of the house.

Fertilizers.— Soils in which considerable humus, especially crimson clover or vetch, have been turned under, need little fertilization. Stable manure and legumes furnish the most important fertilizer, nitrogen, for the grape. No special commercial fertilizer can be recommended on account of the variability of the soils. A little nitrate of soda applied to each vine each year after growth has started will give good results.

Cultivation.— Clean culture shows up to advantage in the vineyard. It keeps the weeds down, allows the air to get into the soil, liberates plant food, conserves the moisture and keeps the soil in a good physical condition. As the vines mature, the cultivation must be lighter. Do not injure the roots or vine. Where possible, sow a cover crop in late summer or early fall, of some crop that may easily be destroyed between the vines by cultivation.

Pruning and training.— One must keep in mind that the fruit is born on the present season's wood. To have a fine quality

and large-sized berry, do not allow too many buds to develop and thin out the clusters of grapes. Prune early in the spring before

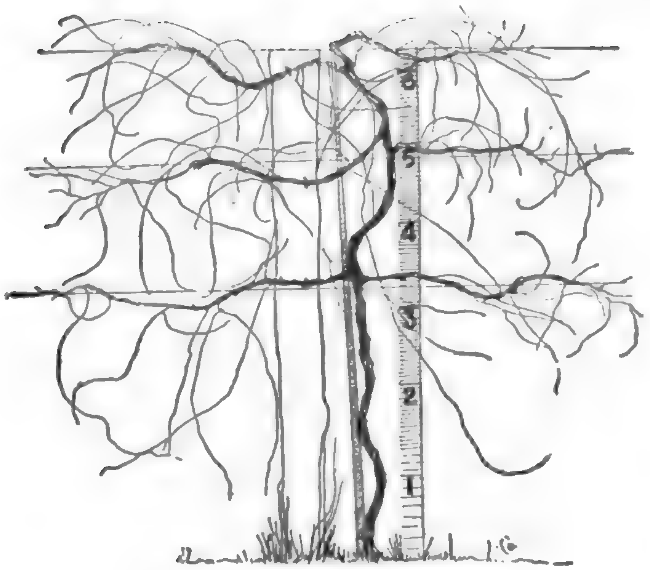

Fig. 94.—Unpruned grapevine trained by the six-arm renewal system.

the sap flows. Figures 93 to 98 will give some idea of pruning and systems of training. For further information, see Farmer's Bulletin No. 471, United States Department of Agriculture, Washington, D. C.

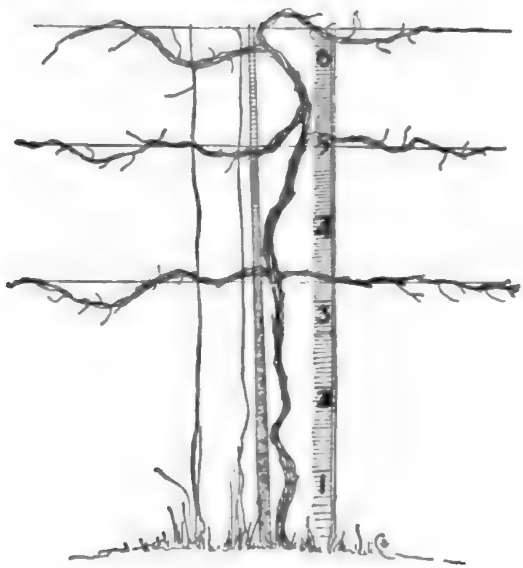

Fig. 95.—Pruned grapevine trained by the six-arm renewal system.

The grapes are sometimes inclosed in two-pound manila paper sacks to protect the berries from mechanical injury, birds, insects, and early frosts. Small holes should be made at the bottom of the bag to allow drainage of water that might enter. The top is folded over and pinned.

The grape is easily propagated by cuttings

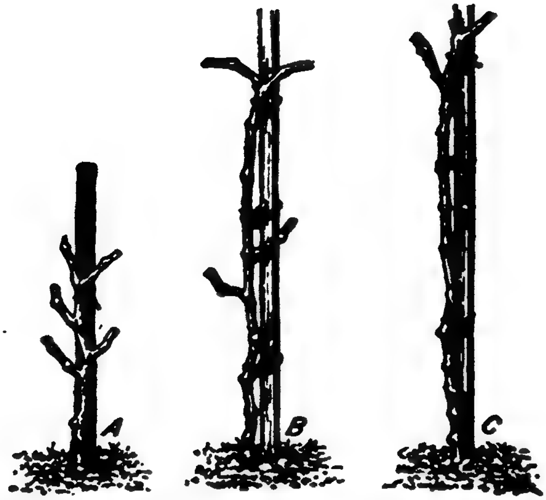

FIG. 96.—Vines headed back for different systems of training: *A*, the spur and fan systems; *B*, the four-arm renewal system; *C*, the two-arm Kniffin, Munson, umbrella, and overhead systems.—*U. S. Dept. of Agriculture.*

eight to fifteen inches in length, previous year's growth. Cut close to lower bud. bunch with lower ends even, invert in a trench and cover with six inches of sand or soil in the fall of the year. The wood should be dormant and secured before it is frozen. In the spring, the butt ends will have calloused. Plant in a propagating row, allowing two to three of the upper buds to project.

FIG. 97.—A vine pruned according to the high renewal system and tied.—*New York State College of Agriculture.*

FIG. 98.—A vine trained according to the high renewal system before pruning.—*New York State College of Agriculture.*

Canes may also be layered in the soil, fall and spring, and severed from parent plant after the various shoots appear, and the canes form roots. Severing from the parent plant should be done when the vine is dormant.

Winter protection.—Where the winters are severe, the vine is released from its support and covered with a little soil which should be removed early in the spring. This practice is seldom necessary where the vine is protected from the driving winds of winter.

INSECTS OF THE GRAPE

INSECTS	CONTROL	REMARKS
Flea beetle	Hand pick. Spray 4 lbs. arsenate of lead (paste) to 100 gals. Bordeaux	The Bordeaux checks the black rot. The poison kills the larva of the beetle.
Leaf hopper	Spray under side of leaves, "black leaf 40", ¾ pint–100 gals. water and 5 lbs. soap	Found sucking sap on under side of leaves. Spray about July 1. Repeat in 10 to 14 days
Root worm	Cultivate close to vines in June. Spray after beetle appears, 3 lbs. arsenate of lead to 50 gals. of water	White grub, feeds on roots. This solution should be sweetened with 1 gal. of molasses.
Rose chafer	Arsenate of lead spray. 4 lbs. to 50 gals. water	Destroys blossom and foliage. Add 1 gal. molasses

DISEASES OF THE GRAPE

DISEASES	CONTROL	REMARKS
Black rot	Bordeaux mixture, 4-4-50 when growth is 8-10 inches long. Second spray after blossom period is over. Third when berries are size of peas	Burn all mummy berries. Plow under diseased fruit and leaves early in the spring. Sometimes a 4th spray is necessary 10-14 days after the 3rd
Downy mildew	Bordeaux 4-4-50	Spray just before rainy season

FIG. 99.—Grape leaf showing patches of downy mildew.

CHAPTER XI

INSECTICIDES AND FUNGICIDES[1]

Ammoniacal copper carbonate.—This is not as good for general purposes as Bordeaux mixture. It is used instead of Bordeaux when it is desirable to avoid the spotting of leaves or ripening fruit. It is prepared as follows: Weigh out the proper amount (five ounces) of copper carbonate, and use just enough ammonia to dissolve it. If the ammonia is strong it should first be diluted with water. Then add the proper amount of water (fifty gallons).

Arsenate of lead.—Arsenate of lead is one of the most valued of the arsenical insecticides. It has in many cases entirely displaced Paris green with orchardists, and there are at least three good reasons for it:

1. The arsenate of lead has great adhesive qualities. It will not wash off, even in heavy showers of rain. Some of our experiments here at the Station showed the presence of this arsenate on the leaf, in sufficient quantity to kill insects, ten weeks after spraying.
2. It can be used in any strength without burning the foliage of the plant sprayed.
3. It has some fungicidal properties that are increased when added to lime sulphur.

Arsenate of lead can be made at home or bought in paste form on the market. Ordinarily it will be easier to buy the prepared material.

FORMULA FOR HOME-MADE PREPARATION:

22 ozs. acetate of lead (sugar of lead) dissolved in 2 gallons of warm water in a wooden pail.

8 ozs. arsenate of soda dissolved in 1 gallon warm water in another wooden pail.

These two solutions, poured together, make a sufficient quantity of poison for fifty gallons of spray.

Three pounds of the commercial paste are recommended for fifty gallons of spray.

Arsenite of lime.—This is essentially a home-made prepara-

[1] By permission of Minnesota Experiment Station.

tion. If made properly, it is just as good as Paris green, and is much cheaper. The best method of preparation is as follows:

FORMULA FOR STOCK SOLUTION:
White arsenic, 1 pound.
Crystal sal soda, 4 pounds.
Water, 1 gallon.

Boil these in an iron kettle for twenty minutes, or until thoroughly dissolved. *The kettle must be kept exclusively for this purpose.* The soluble material obtained is arsenite of soda, and can be stored away in jugs or bottles, labeled "poison," for future use. For forty or fifty gallons of spray, take one and one-half to two pints of this solution and four pounds of freshly slaked lime. Dilute the lime and strain; then add the stock solution. Pour into the spray barrel and it is ready for use.

Bordeaux mixture.—This is made of copper sulphate (bluestone), quicklime and water. It is used in various strengths, the 5-5-50 being probably that in most common use, although the 4-4-50 will probably give equally good results. 5-5-50 simply means that five pounds of copper sulphate, five pounds of lime and fifty gallons of water have been used in the preparation of the spray. In the same way 2-2-50 would mean that two pounds of copper sulphate, two pounds of lime and fifty gallons of water have been used. The number of pounds of copper sulphate is indicated by the first figure, the number of pounds of lime by the second, and the number of gallons of water by the third.

FIG. 100.—Making Bordeaux mixture. The two men pour together the diluted lime milk and the bluestone solution into a barrel or spray tank and stir well.—*Farmers' Bulletin 243.*

One of two methods may be used in making Bordeaux. Either it may be made directly, or stock solutions may be made and these stock solutions used whenever the fungicide is needed. In making the spray directly, take five pounds of copper sulphate, put it into a coarse gunnysack, and hang it in a barrel containing twenty-five gallons of water. Being suspended, the copper sulphate will dissolve much more readily than if put into the

bottom of the barrel. Now slake carefully five pounds of good quicklime, using just enough water to slake it slowly. Be sure that the lime is not at all air-slaked. When the lime is slaked, add enough water to make twenty-five gallons. Now stir it carefully and then pour together the copper sulphate solution and the milk of lime. It is desirable to have a slight excess of lime, since it prevents any injurious action of the copper salts. If there is an excess of copper, foliage injury is liable to result. Therefore, two simple tests should be made to determine whether or not the mixture is safe to use. Take a piece of newly-filed iron or steel and put it into the mixture for about a minute. If it has a copper coating when it is taken out, there is an excess of copper, and more lime should be added. To determine whether or not there is a sufficient amount of lime in the mixture, pour some of it into a flat dish and blow on it for a few moments. If a film forms on the surface, enough lime is present; if not, more should be added.

In making stock solutions, dissolve copper sulphate in water at the rate of one pound to one gallon of water. Slake the lime slowly in another receptacle, and, when slaked, add water until a thick lime milk, one pound to one gallon of water, is formed. When using the stock solution in making up the spray mixture, one gallon of copper sulphate solution represents one pound of copper sulphate, and one gallon of lime water represents a like amount—more or less, depending on the quantity of water used in making the stock solution. The proper amount of stock solutions should be diluted separately before they are poured together. The stock solution of lime should be first run through a fine-mesh sieve, to remove all lumps which might clog the nozzle of the sprayer.

Carbon bisulphid.—This is a very inflammable liquid, that volatizes readily when exposed to the air. It is one of the gaseous insecticides used against grain weevils, etc.

Copper sulphate wash.—

FORMULA:

Copper sulphate, 3 pounds.
Water, 50 gallons.

This is used as a wash on dormant trees, for the prevention of such diseases as apple scab. It must never be used on trees after the buds have burst.

Corrosive sublimate.—

FORMULA:

Mercury bichloride (corrosive sublimate), 2 ounces.
Water, 15 gallons.

This is an extremely poisonous mixture, and should be handled with great care. It is very effective against potato scab. It should not be made in tin vessels, as it corrodes them.

Crude petroleum.—This is an oily, inflammable liquid, that, when refined, yields such products as paraffin, lubricating oil, kerosene, etc. A petroleum having a specific gravity of forty-three degrees (Baume scale) is an excellent insecticide for scale insects. In fact, it was used very successfully against the San José scale until the lime-sulphur wash was found to be better.

Formalin.—

FORMULA:

Formalin (40% formaldehyde), ½ pound.
Water, 15 gallons.

This is used in treating seed for prevention of such diseases as potato scab.

Hellebore.— This is a stomach or internal insecticide. It is not poisonous to man, as are the arsenical insecticides, and therefore is used where there is danger of poison remaining on parts to be eaten. It is often used on currants and gooseberry bushes when the berries are beginning to ripen. This material can be used in the dry form, or as a spray at the rate of two or three ounces to a gallon.

Hydrocyanic acid gas.— This gas is made by dropping potassium cyanide into sulphuric acid and water. The fumes are deadly to all kinds of animal life, and the gas is used only in special cases. As this gas is fatal to human life as well as to insect life, it should be used only by an expert.

Iron sulphide mixture.— This is a comparatively new, but— according to Circular No. 58 of the Bureau of Plant Industry, United States Department of Agriculture — a very promising fungicide. It was tried on apples especially, and gave splendid results in preventing fungous diseases. It also proved non-injurious to the fruit. In preparing this fungicide, it is recommended that a self-boiled lime-sulphur mixture be prepared, as hereinafter described; except that ten pounds of lime and ten pounds of sulphur are used. The mixture is diluted to forty gallons, and then three pounds of iron sulphate (copperas) dissolved in about eight gallons of water, is added.

Kerosene.— This is an excellent contact insecticide. The merest particle of it, coming in contact with any part of the anatomy of an insect, is fatal. Pure kerosene, however, will ordinarily burn the leaves of plants, consequently it is only recommended to be used in the pure form when trees are dor-

mant, or against insects off of plants, for instance the killing of grasshoppers by hopperdozers, or household insects, etc.

Kerosene emulsion.— This is probably the best form into which kerosene can be put for spraying growing plants. A stock emulsion is made as follows:

Hard laundry soap shaved fine, ½ pound.
Water, 1 gallon.
Kerosene, 2 gallons.

Dissolve the soap in boiling water, remove from the stove, and immediately add the kerosene; churn with a bucket pump until a soft, butter-like, clabbered mass is obtained. One part of this stock solution is added to ten or twelve of water for spraying. If the stock solution is properly made, this can be used on tender foliage of plants for such insects as plant-lice, etc. (Soft water must be used.)

Lime sulphur.— Within the last few years this wash has become very prominent. It is one of the best scale insecticides yet discovered, and will kill the eggs of plant lice. As an insecticide it has an accumulative action, being more active a few weeks after spraying than at the start. Since coming into prominence as a scale insecticide, it has been found that in its several forms it is also an excellent fungicide, and will, in many cases, replace Bordeaux mixture. There are several formulæ for making this wash, three of which are appended.

THE BOILED MIXTURE (*Home-made*):
Best stone lime, 15 pounds (not over 5% impurities).
Flowers of sulphur, 15 pounds.
Water, 50 gallons.

Slake the lime in a small quantity of hot water, add the sulphur gradually and stir thoroughly. Dilute the mixture to fifteen gallons with water, and boil in an iron kettle, or cook by steam in a barrel for forty-five minutes. Fill the vessel with water to the required fifty gallons; strain the wash through a fine-mesh strainer, and apply hot.

This wash should be applied in the fall after the leaves have dropped, or in the spring before the buds open. Spray thoroughly, covering all parts of the tree.

FORMULA (*Concentrated*):
80 pounds sulphur.
40 pounds best stone lime (95% calcium oxide).
50 gallons water.

The cost of making this material will depend on the amount that can be made at one time, and the cost of material and labor.

The average cost is about two dollars per barrel of fifty gallons. Usually it is not practicable to make as much as fifty gallons at one time, consequently the following directions are for making only twenty-five gallons. Live steam run in a barrel, or fire under an iron kettle, may be used in boiling.

Place five gallons of water and forty pounds of the sulphur in the vessel, and apply heat until the sulphur becomes a smooth paste, stirring constantly. Now add ten gallons of water and twenty pounds of lime, and boil for forty-five minutes. Add water to make the twenty-five gallons. When cooled to sixty-five degrees F., test with the Baume scale; the reading should be about thirty-three degrees.

As a scalecide to use in the dormant season, this should be diluted one to ten (*i. e.,* one part of the above formula diluted with nine parts of water) and six to ten pounds of stone lime added to every fifty gallons of the spray.

As a fungicide for summer use, dilute one to thirty (one part of stock formula diluted with twenty-nine parts of water).

When stored away it is best to cover the solution with a layer of oil about an eighth of an inch thick. This will prevent evaporation and the forming of a crust on the material. The material should not be stored where the temperature may go very low.

In spraying with this mixture, definite dilution must be made, and to do this a Baume scale is required. The amount of dilution will vary from one part of this concentrate in nine or ten parts of water to one part concentrate in thirty or more parts of water. This concentrated material is now on the market in a commercial form, and is generally very reliable.

Self-boiled Lime Sulphur:
Lime, 8 pounds.
Sulphur, 8 pounds.
Water, 50 gallons.

This spray is especially valuable in cases where Bordeaux is injurious to foliage or fruit. The stone fruits, such as plums, are particularly susceptible to Bordeaux injury, while some varieties of apples are badly russeted by it. There is slight danger of injury by the self-boiled lime-sulphur preparation, and it is an efficient fungicide when properly made. It stains the fruit, as does Bordeaux. In making it, eight pounds of lime of good quality should be placed in a barrel, and enough water to nearly cover it should be added. While the lime is slaking, add sulphur which has been run through a sieve to break up the lumps. The sulphur should be thoroughly stirred into the

slaking lime, enough water being added to make a pasty mass. The barrel should now be covered, in order to retain the heat, and the contents should be occasionally stirred. The time required varies with the quality of the lime; if the lime acts quickly, five to ten minutes will be sufficient, while if it acts slowly, fifteen minutes may be necessary. It should not be allowed to stand too long, because it may, in that case, be injurious to foliage. Now add a little water, stirring the mixture while it is being poured in. Then add enough water to bring the total up to fifty gallons. In applying the spray it is necessary to have a good agitator in the sprayer.

Miscible oils (*oils that will mix with water*).— There are several oils on the market that are miscible with water. These make a good winter spray for scales, and are also excellent summer sprays against the same insects. Great care, however, must be taken to obtain the right dilution, as per directions given on container, or burning of the leaves will result.

Paris green.— This is the old stand-by, and is still used by many where an arsenical insecticide is necessary. Our experiments on orchard trees, and other reports, indicate that arsenate of lead is better in every respect; although our potato expert at the Experiment Station, Mr. Kohler, who has experimented with many of the stomach insecticides for potato beetles, finds Paris green the most satisfactory for these pests. It is generally used at the rate of one pound to fifty gallons of spray. In using always first make a paste of the Paris green and water, and then add to the spray material. If water alone is used, two to three pounds of stone lime should be added. If Bordeaux mixture is used, the addition of lime is not necessary.

Potassium sulphide (*Liver of sulphur*).—

Formula:

3 to 5 ounces of potassium sulphide.
10 gallons of water.

This is used in place of Bordeaux, to avoid spotting of foliage and fruit. It is considered to be especially effective against powdery mildews, such as the gooseberry mildew. It is also quite extensively used in greenhouses and on shrubbery.

Pyrethrum or insect powder (*Persian Insect Powder, Dalmatian Insect Powder or Buhach*).— This is a powder from the ground-up flowers of the pyrethrum plant. It is a contact insecticide, and is used against fleas, cockroaches, etc. If the powder is burned in a room, the fumes will destroy mosquitoes and flies. Purchase only when warranted fresh, and then, when in sealed cans.

Soap.— Ordinary soap is a valuable contact insecticide.

FORMULA:

1 pound Ivory soap or other soap of known quality.
14 gallons water.

Boil the soap in five or six gallons of water until dissolved; dilute with water to fourteen gallons and spray while still warm. It is recommended for plant lice, red spiders, etc.

Sulphur.— Flowers of sulphur is often dusted on plants to prevent such diseases as the powdery mildews.

Tangle-foot.— Is a sticky material often used on trunks of trees, etc., to prevent caterpillars from crawling up to the leaves, or to prevent wingless females of some insects crawling up the trunk to lay their eggs.

The resin-lime mixture.— This is a mixture often used, in combination with a fungicide or an insecticide, to insure the sticking of the necessary poisonous material to smooth, glossy leaves.

FORMULA:

Pulverized resin, 5 pounds.
Concentrated lye, 1 pound.
Fish or other animal oil, 1 pint.
Water, 5 gallons.

Place the oil, the resin and one gallon of the water in an iron kettle, and heat until the resin softens; then add the lye and stir thoroughly. Add to this four gallons of hot water, and boil until a little mixed with cold water gives a clear, amber-colored liquid. Add water to make up to the five gallons.

This is our stock solution. In spraying with Paris green or Bordeaux mixture, take two gallons of this mixture, dilute it to ten gallons, and add to forty gallons of spray.

Tobacco.— Tobacco is a very important contact insecticide. As a powder, it is one of the best remedies for root-lice on trees. It may also be used in the form of dry stems applied in the same way as the dust. As a decoction of the stems (the liquid obtained from boiling in water), it may be used as a spray against plant-lice. This decoction is also good for lice on cattle. Tobacco-smoke, when generated in an enclosed space, kills numerous soft-bodied insects. There are several commercial forms of tobacco decoctions on the market, namely Nicotine, Black Leaf and Nicofume. The latter is very highly recommended by green-house men for the green fly on lettuce. We have found it excellent for all kinds of plant-lice.

Whale oil soap (*Fish oil soap*).—This is a commercial product

and is a good contact insecticide, particularly for soft-bodied insects like plant-lice and slugs.

Dry lime sulphur.— This is frequently used combined with powdered arsenate of lead to control fungus diseases and to destroy chewing insects in both orchard and garden. These materials may be applied by dusting, and by combining them with water.

The advantages of the dry mixtures on the liquid are as follows:

1. Cost of operation is low.
2. Where the water problem is difficult to solve, the dust spray is highly recommended.
3. Dusting is effective in destroying both insects and disease.
4. The material takes up less room and is shipped at low cost.
5. The materials are not injured by frost.
6. Both the dry lime sulphur and arsenate of lead may easily be mixed with water if the liquid solution is desirable. The dry material is applied at the rate of twelve to fourteen pounds to fifty gallons of water (dormant spray) for a liquid solution. To control the apple scab and the codling moth, apply at the rate of one and one-half pounds of arsenate of lead plus three pounds of dry lime sulphur to fifty gallons of water (summer spray).

For the home garden, the following combinations and amounts are recommended:

Dry Arsenate of Lead:
- Seed Fruits and Truck Crops:
  - 3 to 4 level tablespoons to one gallon water.
- Stone Fruits:
  - 2 to 3 tablespoons to one gallon water.

Arsenate of Calcium:
- Seed Fruits and Truck Crops:
  - 1½ to 2 tablespoons to one gallon water.
- Potatoes:
  - 2 to 3 tablespoons to one gallon water.
- Stone Fruits:
  - 1 to 1½ tablespoons to one gallon water.

Paris Green:
- 1 to 2 level teaspoons to one gallon water.

Insecto:
- General Truck Crops and Seed Fruits:
  - 8 to 9 level tablespoons to one gallon water.
- Stone Fruits:
  - 5 to 6 tablespoons to one gallon water.

Dry Lime-Sulphur:

Dormant Spray:

8 to 10 level tablespoons to one gallon water.

Summer Spray—Seed Fruits:

1 to 2 tablespoons Dry Lime-Sulphur.

Summer Spray—Stone Fruits:

¾ to 1 tablespoon Dry Lime-Sulphur.

Tuber-Tonic:

8 to 9 level tablespoons to one gallon water.

Fungi-Bordo:

7 to 8 tablespoons to one gallon water.

Courtesy of Sherwin-Williams.

Spraying machinery.— An individual may understand thoroughly all about insecticides and fungicides and their application; and yet, unless he is the right kind of man, or has the right kind of machinery to put the material on the plant in proper form, his knowledge avails him nothing. A spray-pump may be capable of applying the spray correctly and economically for a person in one orchard, and not be the right kind for another orchard. Again, one kind of pump may suit one orchardist, and good, clean fruit be the result, though perhaps the pump is not as good as that of his neighbor, who sees no good in spraying because his fruit is spotted or worm-eaten. With the present-day advance in all kinds of machinery, it often pays a man to practically give away an old machine for a new one of more efficient pattern, which may be better suited for the work in hand. Spraying, therefore, is a question of individuality and spraying machinery.

For orchard work it is never advisable to purchase anything smaller than a barrel-pump. A good barrel-pump will last a lifetime, and can be used for purposes other than spraying, such as white-washing, disinfecting, etc. When an orchardist has a sufficient number of trees to require five or six barrels of liquid for one spraying, it is advisable to purchase a large tank, holding two hundred to three hundred gallons, and a double-acting sprayer; or better, if he can afford it, a gasoline sprayer.

Always wash the spraying apparatus out with water after spraying or white-washing, and oil and clean up all parts before putting away for winter.

Some essentials of a good spraying apparatus are:

1. The pump should be brass lined, to prevent corroding or rusting of the parts.

2. The pump must have a sufficiently large air-chamber to

keep the pressure uniform; one that will, with comparative ease, keep, with two leads of hose in operation, a pressure of at least one hundred and fifty pounds.

3. As the principal ingredient in many of the insecticides and fungicides is the fine materials held in suspension, there must be perfect agitators, that will keep the liquid in constant motion.

4. The nozzle must be the best that is suited to the occasion. The nozzles of the "Bordeaux" type are not very satisfactory in ordinary usage. The "Vermorel" gives an excellent fine spray, but often it is misty too soon after leaving the nozzle. The larger types of nozzles, like the "Mistry," are more satisfactory for much of the orchard spraying.

5. Another very important point in spraying is to have a good hose. Often a poor or worn-out hose causes more trouble than all the rest of the apparatus put together. Good hose bands, to hold the hose on the couplings, and long hose-couplings, are essential. A short hose-coupling is often more trouble than it is worth.

6. Bamboo extension rods, with cut-offs at the lower ends, are necessary in orchard spraying. The rod inside the bamboo is made either of iron, brass or aluminum. The latter are lighter to handle, and when properly made are excellent. Extension rods can be obtained from eight to fourteen feet long, but it is not often advisable, in this State, to purchase one over ten feet.

7. A necessity, when spraying compounds are used, is a good strainer. A fine-mesh brass screen, set at an angle in the frame of a box, is the simplest and best.

CHAPTER XII

THE VEGETABLE GARDEN

Preparation of the soil.— The farmer's vegetable garden should be located near the kitchen and no matter what the soil may be, clay, loam, sand or muck, certain vegetables may be raised successfully.

The soil should be well drained.— Vegetables cannot grow where there is standing water, or where the soil is sour. Plow under the sod or heavy application of manure in the spring. The soil should "scour" freely from the plowshare. Have the soil very fine; free from stones or material that will interfere with cultivation.

Soil that is ridged in the fall with a coating of well-decayed stable manure, dished in early in the spring, and then the spring-tooth and spike-tooth harrow worked over the surface, makes an ideal seed bed. Plow deeply.

Fertilizers.— Horse manure where the horses have been bedded in straw, is considered the best for vegetable culture. Never apply burned manure (gray colored straw).

Cow manure is cooler than horse manure, and especially fine for cabbage, cauliflower and Brussels sprouts.

Pulverized sheep or chicken manure is especially fine for a top dressing after the crop has started. Such crops as onions,

THE PLANT FOODS

Select one fertilizer from each group and work it well into the soil

PLANT FOOD NECESSARY	FERTILIZER OR SOURCE	AMOUNT PER SQUARE ROD	HINTS
Nitrogen—Leaf builder	Nitrate of soda	2 lbs. Apply before a rain	For solution, especially for plants (Lettuce) 1½ lbs. to 14 gallons water
Potash—Stem builder	Kainit Sulphate of potash Wood ashes—Hard wood best	3½ lbs. 2 lbs. Apply freely	Very difficult to secure Buy early
Phosphoric acid—Fruit builder	Ground rock acid phosphate Dissolved bone Basic slag	5 lbs. 2 lbs. 5 lbs.	The dissolved bone meal is considered the best. Make your own selection

celery, and lettuce are benefited. Apply sparingly and do not leave any manure on the foliage.

Commercial fertilizers are seldom necessary for the farm garden, but may sometimes be applied after the crop is growing.

Tools for operating the home garden.— Spading fork; hoe (seven inches); rake (steel bow), fifteen teeth; double wheel cultivator; single garden reel, one hundred and twenty feet Italian hemp; auto spray (galvanized iron); galvanized watering can (twelve quarts); hand weeder.

A garden trowel which is sometimes useful in transplanting (twenty-five cents), and also a hotbed soil thermometer (one dollar) may be added to the above list. But few home gardens have hotbeds though they are most valuable and highly recommended.

Hotbed.— Much time may be gained in the out-door culture of vegetables if a hotbed and cold frame are available. It is

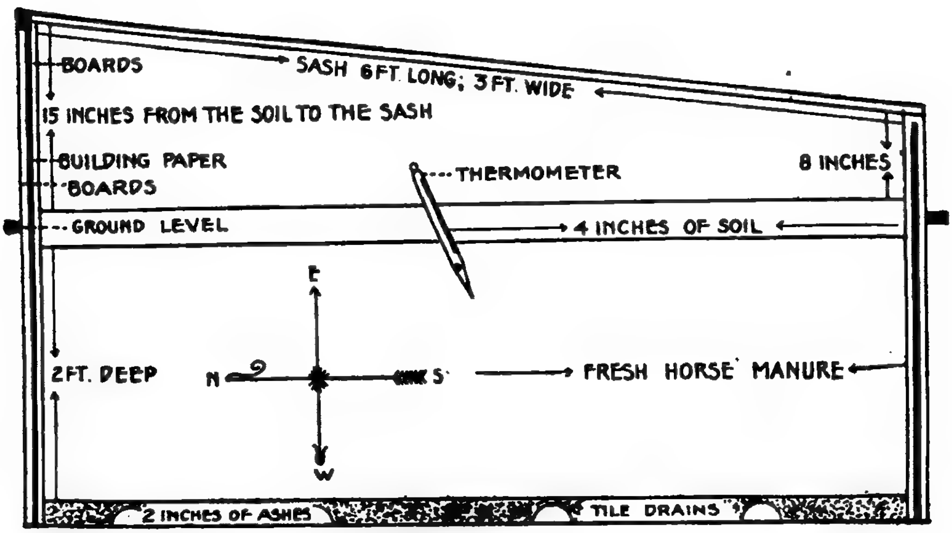

FIG. 101.—Diagram of a hotbed.

necessary to start certain vegetables early in order to get a crop by the end of the season, and it is also necessary to sow the seed of certain crops, transplant the seedlings to the cold frames and finally to the open, after the spring frosts have passed, in order to get more than one crop from the same soil in one season. The advantages of the hotbed and cold frame are: (1) Time may be gained in spring by starting the plants before the frosts have

passed; (2) certain plants which require a long season in order to mature may be started; (3) it is made possible for certain plants like the tomato to produce a large crop before frost (especially true in the north); (4) some crops like lettuce and celery do better if started in the hotbed and transplanted after pruning the root system; (5) the elements, moisture, heat and light are controlled so that the germination of the seed is sure; (6) the first crop of weeds may be destroyed by cultivation, the soil made fine and the arrangement of the garden made more attractive by starting the first crops under glass; (7) if the plants are properly cared for they are strong and resist disease more readily; (8) a means of avoiding insect enemies is provided; (9) tender crops like cucumbers and summer squash may be started early among the other seedlings; (10) a crop of lettuce and other vegetables may be raised after frost sets in, late in the fall.

Fill the hotbed with fresh horse manure where bedding has been straw. Pack tightly. Moisten with hot water to start fermentation. Place four to five inches of clean garden loam over the manure. Place a thermometer as shown in the diagram. Cover with sash. Temperature often rises to one hundred and ten degrees Fahrenheit and higher. Plant seeds after the temperature begins to drop and reaches eighty degrees Fahrenheit. Seeds planted when the temperature is high are baked.

Protect the plants early in the spring and late in the fall by covering hotbed sash with straw mats and light wooden shutters. Ventilate freely on bright days, but do not allow a draft, or chill the plants.

Following is a table of spring crops planted in the hotbed in the vicinity of New York city. For every hundred miles north or south of New York subtract or add from eight to ten days to the dates given.

Early Crops for Hotbed and Transplanting

DATE SOWN	VEGETABLES	TRANSPLANTED TO COLD FRAMES	TRANS-PLANTED TO THE OPEN	READY TO EAT
February 15	Lettuce	March 10	April 15	April 30
	Onions	March 15	May 10	May-Fall
	Beets	March 15	April 25	June 30
	Cabbage	March 15	April 20	May 30
	Cauliflower	March 25	May 1	June 1
	Kohl-rabi	March 15	April 20	June 5
	Celery	April 1	May 1	June 15

CROPS TO BE STARTED AND MATURED IN THE HOTBED. PLANTED IN THE SPRING

DATE	VEGETABLES	DATE OF MATURITY	REMARKS
April 1	Cucumbers	June 10	Plant rows of beets 12 inches apart. Also rows of Radish 10 inches apart and here and there about 12 to 18 inches apart; plant one of the vine seeds about 2 inches in depth
February 15	Summer squash	June 10	
February 15	Beets	June 1	
	Radish	March 25	

PLANTS FOUR WEEKS OLD TRANSPLANTED FROM THE OPEN TO THE HOTBED BEFORE FROST IN THE FALL. ALSO SEED SOWN IN THE FALL

DATE	VEGETABLES	DATE OF MATURITY	REMARKS
October 1	Lettuce (loose) leaf)	November 15	Radish seed may be sown between the rows of growing plants and they mature in about 35 days.
	Radish	October 20	
September 15	Radish	November 15–December	
September 15	Beets (plants)		

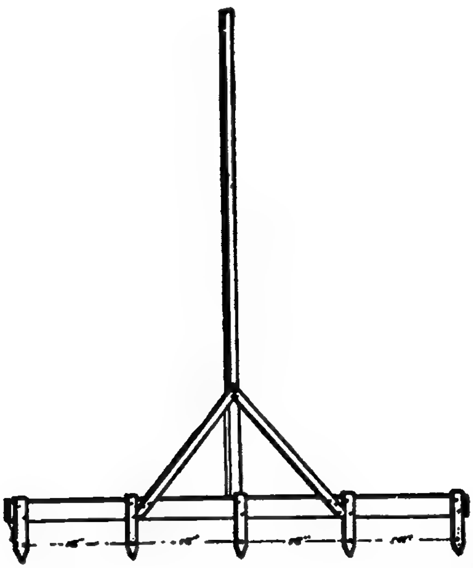

FIG. 102.—A drag marker used in marking off the field when plants are set in checks. —*U. S. Dept. of Agriculture.*

The cold frame is a much cheaper construction, requires no excavation, no heating material or even glass covering. It may be constructed by nailing four twelve-inch boards together, usually six feet long and four feet wide. Place this frame on the surface of the soil and dig up the soil within it. A little finely pulverized and well-decayed manure is not objectionable if properly incorporated into the first two inches of soil. A little soil piled around the outside of the frame will make it firm and keep out the cold air. The covering varies from glass to canvas and burlap.

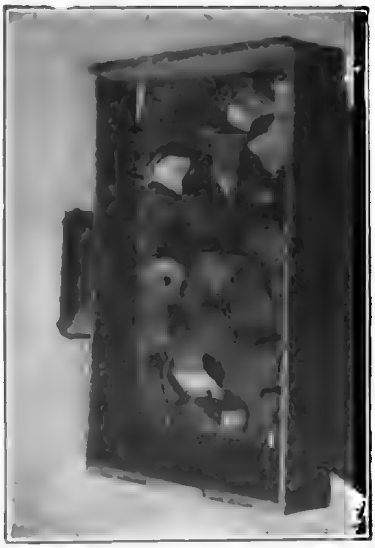

FIG. 103.—Broken bits of pots placed on the bottom of the flat will insure the proper drainage.

FIG. 104.—Sowing seed in a flat. That divided in two sections for two kinds of seed.

FIG. 105.—Sifting soil over the seed. Sand and loam should be used and the seed planted about its own depth.

FIG. 106.—Pressing the soil about the seed hastens germination.

FIG. 107.—Transplanting lettuce. Making the hole with the first two fingers.

FIG. 108.—Note the position of the fingers in pressing the soil about the roots of the plant. It is important to have the soil firm.

FIG. 109.—Flat of Jersey Wakefield cabbage plants one week after shifting.

FIG. 110.—A flat full of thrifty lettuce plants, two by two inches apart each way.

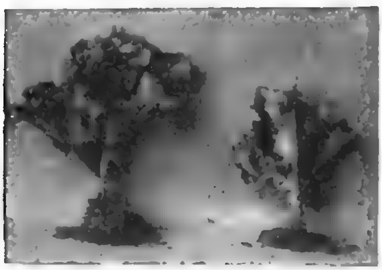

FIG. 111.—*A*, Thrifty lettuce plant before pruning the leaves. *B*, Leaves pruned, the plant is ready to be transplanted to the open.

Fig. 112.—Both of these heads of lettuce were planted at the same times. *A*, Boston Head lettuce going to seed. *B*, Head of Hanson Improved will thrive in hot weather.

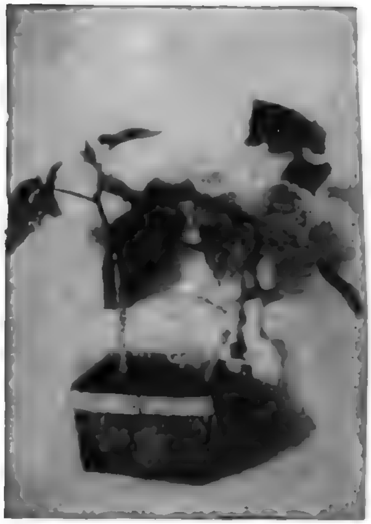

Fig. 113.—Cucumbers started early in a strawberry basket.

The purpose of the cold frame is to have a place in April or May to which to transplant seedlings from the hotbed so that they may develop a more healthy and stocky set of plants. It is also a change from the heat to the temperature out of doors. The cold frame may be covered with any material that will keep out the light frosts. After the frost has passed and the garden soil is properly prepared, these plants may be transferred to the open.

Hardening the plants is a practice necessary if the best results are looked for. In the hotbed and cold frames the plants are supplied with moisture when necessary and protected from winds and cold. In order that these young plants may not feel a shock when placed in the open, you should increase the ventilation until the sash or other protective covering is entirely removed and the plants exposed, and decrease the watering so that the plant becomes accustomed to nature's periods of supplying moisture.

Before transplanting to the field, soak the soil with water so that the soil may adhere to the roots of the young plants, and water the plants again as soon as they are set in the soil.

The cold frame may be taken apart after its usefulness has passed and the space used for various garden crops.

Garden 110 by 200 Feet

Vegetable	Number of row	Amount of seed	Cost of seed	Planting			
				Time	Method	Depth (inches)	Dist. apart of seed (inches)
Artichokes, bur	¼ to 32	18 roots	$2.25	....	....	....	....
Artichokes, Jerusalem	¼ to 32	48 roots or 1 qt.	.25	....	....	....	....
Asparagus	33	200 two-yr. roots	2.00	....	....	....	....
Beans, green	½ of 7	1 qt.	.35	May 1-15	Drills	1	1 to 2
Beans, wax	½ of 7	1 qt.	.40	May 1-15	Drills	1	1 to 2
Beans, pole	31	1 qt.	.35	May 1-15	Hill, 6 to 8 seeds	1	1 to 2
Beets, early	8	¼ lb.	.50	Apr. 15	Drills	½ to ¾	¼ to ½
Beets, late	4, 5	½ lb.	.75	July 15-30	Drills	½ to ¾	¼ to ½
Brussels sprouts	13	1 pkg.	.10	Mar. 15	Hotbed	½	½
Cabbage, early	19	1 pkg.	.10	Mar. 15	Hotbed	½	¼ to ½
Cabbage, late	½ of 27	1 pkg.	.05	May 15	Cold-frames	½	¼ to ½
Cabbage, red	¼ of 27	1 pkg.	.05	Apr. 15	Hotbed	½	¼ to ½
Cabbage, Savoy	¼ of 27	1 pkg.	.05	Apr. 15	Hotbed	½	¼ to ½
Carrots, ½ long	¼ of 10	1 oz.	.25	Apr. 15-30	Drills	¼ to ½	¼ to ½
Carrots, long	¾ of 10	2 oz.	.40	Apr. 30	Drills	¼ to ½	¼ to ½
Cauliflower	¾ of 8	1 pkg.	.20	Apr. 15 and later	Hotbed	½	¼ to ½
Celeriac	½ of 9	1 pkg.	.05	May 1	Hotbed	¼ or less	Thick
Celery, early	20	1 pkg.	.10	Mar. 15	Hotbed	¼ or less	Thick
Celery, late	18, 19	1 pkg.	.10	May 1	Hotbed	¼ or less	Thick
Chard, Swiss	Herb bed	1 pkg.	.10	Apr. 15	Drills	½ to ¾	¼ to ½
Corn, early	27	1 pt.	.20	May 15 or earlier	Hills	1	3
Corn, mid-season	28, 29	1 qt.	.30	June 1	Hills 18 in. apart	1	3
Corn, late	30	1 pt.	.15	June 15	Hills 24 in. apart	1	3
Cucumbers	½ of 22	1 pkg.	.10	May 15	Drills	½ to ¾	1
Eggplant	½ of 16	1 pkg.	.10	Apr. 15	Hotbed	½	½
Endive	½ of 9	1 pkg.	.05	July 1	Drills	½	½
Horse-radish	¼ of 32	50 roots	.50	....	....	....	....
Kohl-rabi	¼ of 8	1 pkg.	.05	Apr. 15	Hotbed	½	½
Leek	Between tomatoes	2 pkgs.	.10	Apr. 1	Hotbed	½	¼ to ½
Lettuce	In melons and elsewhere	6 pkgs.	.50	April-Sept.	Hotbed and field	¼ to ½	¼ to ½
Muskmelons	Bed	3 pkgs.	.40	May 15	Hills, plow.	½ to ¾	1
Okra	¼ of 16	1 pkg.	.05	Mar. 15	Hotbed	½ to ¾	¼ to ½
Onions	13, 14, 15 and between	3 oz.	.45	Apr. 1 or later	Hotbed and outside	½	¼ to ½
Parsnips	11	2 oz.	.25	Apr. 15	Drills	¼ to ½	¼ to ½
Peas, early	1	2 qts.	1.30	Apr. 1	Drills	1½ to 2	Thick
Peas, mid-season	2, 3, 4, 5	1 pk.	4.00	Apr. 15	Drills	1½ to 2	Thick
Peas, late	6	2 qts.	1.00	May 30	Drills	1½ to 2	Thick
Peppers	¼ of 16	1 pkg.	.05	Apr. 1	Hotbed	½	½
Potatoes, early	21, 23	4 pks.	2.00	May 1	Drills	4	10
Potatoes, late	24, 25, 26	1½ bu.	3.00	May 15	Drills	4	10
Pumpkins	In sweet corn	2 oz.	.20	May 15	Corn hills	¾ to 1	2 or 3 in every 3d corn hill
Radishes, early	In melons and vacant places	3 oz. in pkgs.	.30	April-Aug.	Drills and hotbed	½	¼ to ½
Radishes, winter	Herb bed	2 pkgs	.10	June 1	Drills	½	½
Rhubarb	¼ of 32	16 roots	2.50	....	....	....	....
Salsify	12	½ lb.	.50	Apr. 15	Drills	½	½
Spinach	Early 6, 18, late anywhere	½ lb.	.25	Apr. 1 on	Drills	½	¼ to ½
Squash, early	½ of 22	2 pkgs.	.10	May 1-15	Hills, 6 to 8 seeds	¾ ¾	3 to 6 3 to 4

GARDEN 110 BY 200 FEET—*Continued*

VEGETABLE	NUMBER OF ROW	AMOUNT OF SEED	COST OF SEED	PLANTING			
				Time	Method	Depth (inches)	Dist. apart of seed (inches)
Squash, late	2, ½ of 22	¼ lb.	.40	May 15 –July 1	Hills		
Tomatoes	17	3 pkgs.	.25	Apr. 1	Hotbed	¼ to ½	¼ to ½
Turnips, early	9	2 oz.	.20	Apr. 15	Drills	½	¼ to ½
Turnips, late	20	2 oz.	.20	July 15 –20	Drills	½	¼ to ½
Balm	Herb bed	1 pkg. each	.05	May 1–15	Hotbed	¼ to ½	¼ to ½
Basil, sweet			.05				
Caraway			.05				
Catnip			.10				
Dill			.05				
Horehound			.05				
Mint			.25				
Sage			.05				
Savory, summer			.05				
Thyme			.05				
Total	....	....	$28.70				

GARDEN 110 BY 200 FEET—*Continued*

VEGETABLES	TRANSPLANTING		THINNING			HARVESTING		Remarks
	Time	Distance apart of plants (inches)	Time	Space between plants (inches)	Method of disposal	First	Final	
Artichokes, bur	Apr. 15	36	....	....	....	Sept. 30	Oct. 30–Nov. 30	
Artichokes, Jerusalem	Apr. 15	12	....	....	....	Sept. 30	Nov. and next spring	
Asparagus	Apr. 15	12	....	....	....	2 years after planting	May to June 1 after 3 years	On to July 4
Beans, green	....	....	June 15	3 to 4	Destroy	July 1–15	Sept. 1–15	
Beans, wax	....	....	June 15	3 to 4	Destroy	July 1–15	Sept. 1–15	
Beans, pole	....	....	....	....	....	Aug. 1–15	Sept. 30 on	
Beets, early	....	....	June 15	3	Greens	June 15–30	Aug. 1	
Beets, late	....	....	July 1–15	4	Greens	Sept. 15–30	Oct. 15	
Brussels sprouts	Apr. 15–30	18	....	....	....	Aug. 1–15	Oct. 15 on	
Cabbage, early	Apr. 15–30	18	....	....	....	July 1–15	Sept. 1	
Cabbage, late	June 15–30	24	....	....	....	Aug. 15–30	Nov. 1 on	All winter
Cabbage, red	May 20–30	24	....	....	....	July 30	Oct. 30 on	All winter
Cabbage, Savoy	May 20–30	24	....	....	....	July 30	Oct. 30 on	All winter
Carrots, ½ long	....	....	June 1–15	2	Destroy	July 1–15	Aug. 15	
Carrots, long	....	....	June 1–15	3	Destroy	July 15–30	Oct. 1–15	
Cauliflower	June 20–30	18	....	....	....	Aug. 1–15	Oct. 15	To store for winter
Celeriac	June 10–20	10 to 12	....	....	....	Sept. 15	Nov. 1 on	Winter
Celery, early	May 1–10	4	....	....	....	June 1–15	July 15	
Celery, late	June 10–20	5 to 6	....	....	....	Sept. 15	Nov. 1 on	Winter
Chard, Swiss	....	....	June 15	12	Greens	June 15–30	July 15	

GARDEN 110 BY 200 FEET—*Continued*

VEGETABLES	TRANSPLANTING		THINNING			HARVESTING		Remarks
	Time	Distance apart of plants (inches)	Time	Space between plants (inches)	Method of disposal	First	Final	
Corn, early	....	....	July 1-4, plants	Hills 18	Destroy	July 20-30	Aug. 5	
Corn, mid-season	....	....	July 15	To 4 plants in hill	Destroy	Aug. 1-15	Sept. 1	
Corn, late	....	....	July 30	To 3 plants in hill	Destroy	Sept. 1-15	Sept. 30	
Cucumbers	....	....	July 1-15	6	Destroy	Aug. 15-30	Sept. 15-30	
Eggplant	May 20-30	15	....	....	....	Sept. 1	Sept. 15	
Endive	....	....	June 15	12	Greens	Sept. 15	Oct. 30	
Horse-radish	Apr. 15	12	....	....	....	Nov. 1 on	Fall and next spring	Winter
Kohl-rabi	June 15-30	9	....	....	....	July 30	Aug. 15-30	
Leek	May 1-10	3	....	....	....	June 1	July 15	
Lettuce	Apr.-Aug.	7 x 7 in. hotbed 10 outside	....	....	....	May 20-30	All seasons	
Muskmelons	....	....	June 15	6	Destroy	Aug. 15-30	Oct. 15	
Okra	May 15-30	12	....	....	....	July 15-30	Sept. 30	
Onions	Apr. 1-30	3	....	....	....	June 1-15	Aug. 15-30	
Parsnips	....	....	June 1-15	4	Destroy	Sept. 1	Oct. 30 on	Again in spring
Peas, early	....	....	....	....	....	June 15-20	July 1	
Peas, mid-season	....	....	....	....	....	July 1-15	July 30	
Peas, late	....	....	....	....	....	July 30	Aug. 15-30	
Peppers	May 20-30	12	....	....	....	Aug. 15	Oct. 1-15	
Potatoes, early	....	....	....	....	....	June 15	Aug. 1	
Potatoes, late	....	....	....	....	....	Aug. 15-30	Oct. 15	For winter
Pumpkins	....	....	June 15	2 in hill	Destroy	Oct. 1	Oct. 15	For winter
Radishes, early	....	....	....	....	....	May 1	All seasons	
Radishes, winter	....	....	June 15	2 to 6	Destroy	Sept. 1	Oct. 15	Winter
Rhubarb	Apr. 15	36	....	....	....	May 15	July 15	
Salsify	....	....	June 1-15	4	Destroy	Sept. 1	Oct. 30 on	Winter
Spinach	....	....	May 30 on	3	Destroy or greens	May 15-30	June 30 on	
Squash, early	....	....	June 15	3 or 4 in hill 3 ft.	Destroy	June 15	July 15	
Squash, late	....	....	June 15 on	2 or 3 in hill 6 ft.	Destroy	Sept. 1	Oct. 15	Winter
Tomatoes	May 20-30	36	....	....	....	June 15-30	Sept. 15-30	
Turnips, early	....	....	May 15	6	Destroy	June 1-15	Aug. 1-Sept. 15	
Turnips, late	....	....	Aug. 1	10 to 12	Destroy	Sept. 15	Oct. 15	
Balm								
Basil, sweet								
Caraway								
Catnip								
Dill								
Horehound								
Mint								
Sage								
Savory, summer								
Thyme								

VARIETIES

Perennials

Asparagus.— Strong, well-developed, two-year-old roots of Argenteuil, Palmetto, or Conover's Colossal.

Horse-radish.— Sets of Bohemian.

Rhubarb.— Linnæus or Victoria.

FIG. 114.—The wrong way to push a seeder or hand-cultivator. It is almost impossible to control the direction of the machine and the operator tires quickly.

Artichokes.— Green Globe, which is cultivated for its flower heads to be cooked as asparagus, is the variety most commonly desired. If the edible part wanted is the root, Jerusalem is the variety to use. Plant the latter variety one foot apart in the row, and the former three feet apart.

Place perennials at one end of the garden, so that they will not interfere with the general culture of the annuals.

Annuals

Beans (all dwarfs, Green Snap).— Six Weeks and Giant Stringless Green-pod Valentine are very early.

Beans (all dwarfs shell).— Dwarf Horticultural, The Goddard, and Bush Lima.

Beans (all dwarfs, yellow, or wax).— Wardwell's Kidney Wax, Golden Wax, Stringless Refugee Wax, and others are good.

Beets (early).—Crosby Egyptian, Early Eclipse. The former is very desirable.

Beets (late).— Edmond's Blood for a standard, Detroit Dark Red of a deep, blood-red color.

Brussels sprouts.— Long Island and Danish are very good.

Cabbage (early).— Early Jersey Wakefield, Early Erfurt.

Cabbage (late).— All Seasons, Danish Ball Head, Volga, Drumhead. Extra Choice Drumhead Savoy is a very fancy cabbage.

Cabbage (red).— Red Dutch, Red Rock, Red Erfurt.

Carrots (one-half long).— Danvers One Half Long, Chantenay One Half Long, Ox-heart.

Carrots (long).— Danvers, Long Orange.

Cauliflower.— Snow-ball, Erfurt.

Céleriac.—Apple Shape.

Celery (early).— Golden Self-blanching.

Celery (late).— Self-bleaching, Winter Queen, Kalamazoo, Boston Market, Giant Pascal.

Chard (Swiss).— Order by name only, or variety Giant Lucullus.

Corn (early).— Metropolitan, Adams, Cory, Aristocrat.

Corn (mid-season).—Quincy, Market, Golden Bantam, Black Mexican, Country Gentleman.

Corn (late).— Stowell's Evergreen, some of the mid-season varieties planted later.

FIG. 115.—The right way to push a seeder or hand-cultivator. Stand up to the machine and push it with your body, not your arms. More force and less fatigue.

Cucumbers.— Arlington White Spine, Davis, Cool and Crisp, Fordhook.

Eggplant (early).— Black Beauty, New York or Long Island Improved, Black Pekin.

Endive.— White Curled, Batavian.

Kohl-rabi.— Early White or Purple Vienna.

Leek.— Giant Carentan, American Flag.

Lettuce (forcing).— For forcing in hotbed, Hittinger's Forcing.

Lettuce (head).— Belmont Mammoth, Salamander, Big Boston, All Heart.

Lettuce (loose leaf).— Grand Rapids, Early Curled Simpson and Silesian.

Lettuce (summer).— Hanson Improved and Iceberg.

Lettuce (cos).— Kingsholm Cos, Paris White Cos.

Muskmelons.— Rocky Ford, Jenny Lind, Gem, Miller Cream, Hackensack.

Onions (yellow).— Danvers, Southport, Prize-taker, Australian Brown.

Onions (red).— Wethersfield, Danvers, Southport.

Onions (white).— Southport.

Onions (top).— Plant in the fall, harvest in the spring. Multiplier and Egyptian.

Parsnips.— Hollow Crown.

Peas (early dwarf).—Surprise, Gradus, Alaska, Gem, Eureka, Nott's Excelsior.

Peas (mid-season, dwarf).— Thomas Laxton, American Wonder, Early Morn, Admiral Dewey, Abundance.

Peas (late, dwarf, telephone).— Champion of England is a tall grower on mellow soil. Substitute the Dwarf Champion for better results in the very small gardens, yet there is no better yielder on the market than Champion of England. Dwarf White Sugar.

Peppers.— Chinese Giant, Ruby King, Red Cayenne.

Potatoes (early).— Bliss Triumph, Early Rose, Early Northern, Early Ohio.

Potatoes (late).— Carman Three, Rural New Yorker, Sir Walter Raleigh, Irish Cobbler, Green Mountain, State of Maine.

Pumpkins.— Sugar, Quaker Pie, Cashaw.

Radish (early).— Cardinal Globe, Crimson Giant, French Breakfast.

Radish (summer).— Beckert's Chartier, Icicle.

Radish (winter).—Long Black Spanish, Celestial, Long White Spanish, Scarlet China.

Salsify.— Sandwich Island, Long White.

Spinach.— Giant Thick Leaf, Long Season, New Zealand.

Squash (early).— White Bush, Crook Neck.

Squash (late).— Hubbard, English Marrow, Boston Marrow, Delicious.

Tomatoes.— Earliana, Bonnie Best, Chalk's Jewel, Model, Ponderoso, Stone, Champion.

Turnips (early).— White Milan, Purple Top Milan, Snowball.

Turnips (late).— American Rutabaga, White Rock, White Egg.

Storing.— There are three essential principles which must be considered if we are to keep both vegetables and fruits fresh during the winter months: The regulation of temperature, of moisture, and of ventilation.

Vegetables.— If vegetables are stored in a storage building, root cellar or outdoor pit, the temperature should be about thirty-two to thirty-four degrees F. Some vegetables, like cabbage, can stand 25 degrees F. above zero and even lower, but for general purposes the temperature should be a little above freezing. If the air is too dry, the vegetables shrink and become use-

A B C
FIG. 116.—*A*, The top of the beet cut too close. *B*, Too small to store for winter. *C*, Beets the right size, tops cut properly for storing.

A B
FIG. 117.—*A*, Celery plant as taken out of the ground ready for packing. *B*, Box in which celery may be kept in the cellar during winter.

less, but if kept moist they retain their plumpness. When root crops, such as turnips, or carrots, get wet and the temperature goes up, decay is sure to set in and it spreads quickly.

The air must be kept fresh, cool and clean. Ventilation is not always an easy practice, but it should never be neglected. There is considerable heat in vegetables and steam may be seen escaping from a storehouse window on opening it on a cold, clear morning. This is usually a good indication of the proper circulation of air.

Roots should be fully grown, all badly bruised roots should be thrown out. The tops should be cut off about an inch above the root. Do not expose the roots to the air too long before storing them. Never wash the soil from the root crops, or cut the roots off cabbage and celery.

Outdoor storage pits.— There is no better way to store vegetables than in the soil, out of doors, and this method of storing may be practiced successfully where the winter temperature does not go too low. Where the temperature frequently drops to

twenty degrees below zero the pitting of vegetables should not be attempted. Such crops as turnips, parsnips, beets, carrots, cabbage and potatoes may be kept until late spring if stored on a well-drained strip of soil. Where the soil is more or less level, dig two trenches eight inches deep on each side of the mound base, which should be about six feet wide and the required length, so that the vegetables may be piled four feet deep. Place on the surface of the ridge about six inches of clean straw.

If the pit is only five feet long, place a ventilator in the center. Pile the vegetables around the ventilator to a height of four feet and cover the mound-shaped pile with six to eight inches of straw. As the weather grows colder, cover the mound with sufficient soil to keep out the frost. It is not a bad idea to throw a strip of canvas over the mound early in the fall to keep out the rain until sufficient soil is added to shed the water. Open the pit at one end and stuff the hole with sufficient straw to keep the frost out after desired vegetables have been removed. Cabbage may be buried three tiers high by standing the cabbage head down on the straw. Cabbage should be the last crop to store, for it quickly decays in warm weather. Remove only the partly decayed leaves and do not disturb the roots.

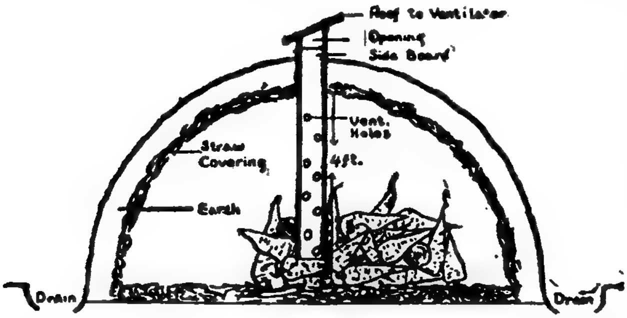

Fig. 118.—Diagram of a vegetable pit. It should run east and west and the mouth of the ventilator should slant north. Have eight inches of straw at the base of the pit. As the weather grows colder add more earth, as indicated, to keep out the frost.

The vegetable cellar.—The great difficulty with most of the cellars is that there has been no forethought regarding a vegetable store room and the furnace and pipes are so placed that it is a problem to construct the proper type of storage room. Select a part of the cellar under a window and construct your storeroom with beaver board on the outside (a non-conductor of heat and cold). While the shape or contrivance may not be ideal, yet it may answer the purpose. Bins may be constructed to divide the potatoes from the roots. The floor, if concrete, should be covered with boards raised from three to six inches from the

concrete. Vegetables placed on the concrete have a tendency to keep the floor moist, which in time will cause decay of the vege-

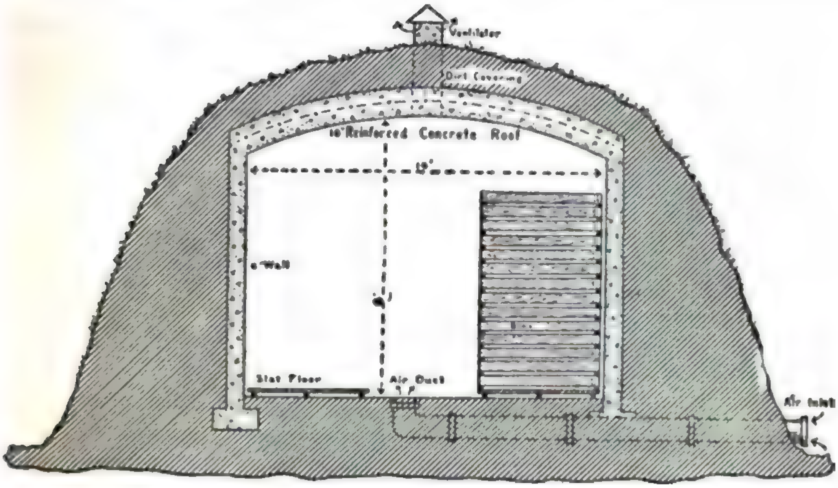

FIG. 119.—Cross section of a concrete storage cellar, showing the arrangement of ventilators, slat floors, and bins, with provision for the circulation of air under and around the slat floors and bins. This cellar is ten feet wide and eight feet high, inside measurement.—*U. S. Dept. of Agriculture.*

tables. Pure air should circulate freely under the vegetables as well as above. The dirt floor is exceptional but is most satisfactory. If the soil is dry there is no danger in placing the vegetables on it. Onions may be stored with other vegetables if placed in crates. Shelves may be constructed on the walls for winter squash, pumpkins and fruit. Roots and potatoes keep better if covered with burlap and if the room is kept dark and cool. Such a vege-

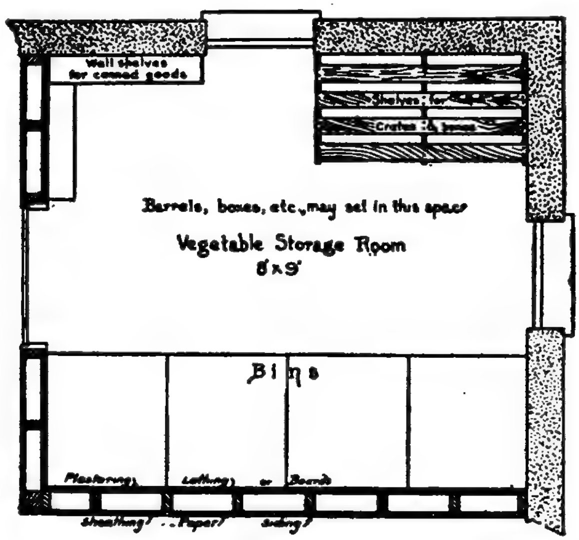

FIG. 120.—Floor plan of a storage room in a corner of a basement. The arrangement of the shelving and bins may be changed to suit conditions. While the construction of the wall may be varied, it must be tight.—*U. S. Dept. of Agriculture.*

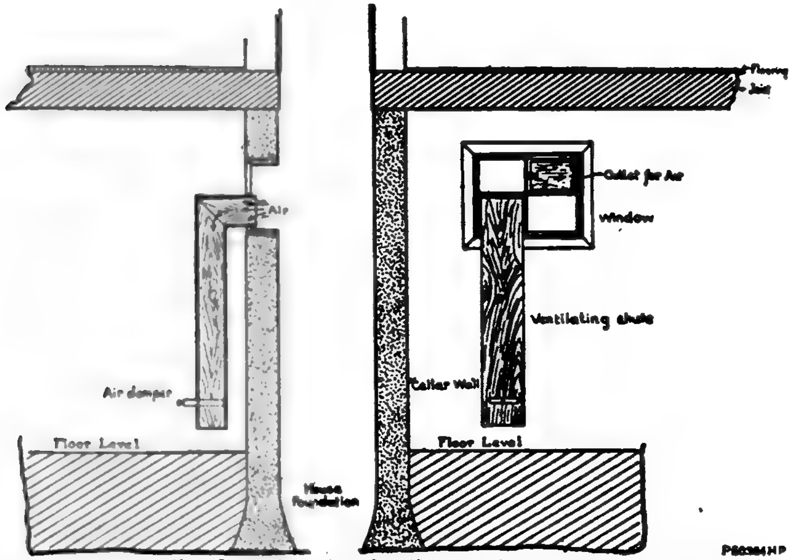

FIG. 121.—Details of construction for the ventilation of a storage room in a basement. The air duct may be made of wood, terra cotta, or metal and installed in place of a pane of glass, thus avoiding cutting through the cellar wall. A hinged door the size of another pane of glass may serve as an outlet for the warm air.—*U. S. Dept. of Agriculture.*

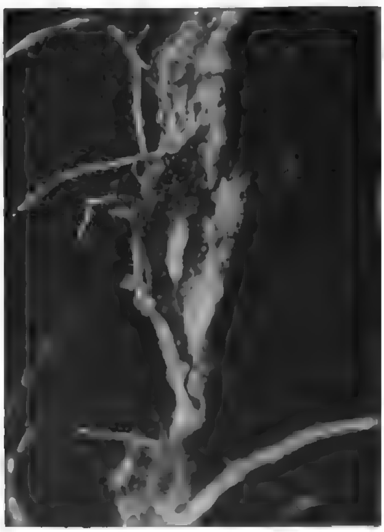

FIG. 122.—Squash borer at work in the stem of a squash vine.

table cellar must be ventilated carefully, for one night's neglect in closing the window may mean an entire loss of the winter supply. A pail of water placed in the center of the room will supply sufficient moisture. Keep a standard thermometer hanging from the ceiling in the center of the room. Keep water in the furnace and a pail of water near to absorb the gas. Never allow the furnace gases to get into the root cellar. If you only have room for a few large boxes in the root cellar, cover the outside of each with beaver board, place a ventilator in the center of each, fill in the roots and cover them with five inches of soil. Place the box as far from the furnace as possible. Also place two strips of board for the box to rest on, so that the air may circulate under it.

VEGETABLES	HARVESTING	STORAGE	TEMPERATURE	
Beans	Fully ripe	Bags hung in dry place	....	Pods may be dried in field or attic floor
Beets	Before frost	Pits, cellar, ventilated barrels or crates	34° F.	Cover roots with soil
Cabbage	After light frost	Outdoor pits or cellars, with roots cut, place on shelves	Just above freezing	Do not store where odor may penetrate
Carrots	Before frost	Outdoor pits or root cellar	34°–35° F.	Cover with soil
Celery	Before severe freezing	Hotbed pits, trenches, boxes or cold frames	Just above freezing	Leave soil on roots. Pack stalks upright. Ventilate. Keep soil moist
Onions	Well matured, dry, before severe frost	Ventilated barrels or baskets, crates, loosely-woven bags	Above freezing	Slight frost does not injure onions
Parsnips	Before soil is frozen hard	Outdoor pits or cellars	Just above freezing	May be left in ground over winter
Pumpkins Squash	Before frost	In rows on shelves	40° F.	Well ventilated
Turnips	Before severe frosts	Outdoor pits or cellars	Above freezing	Strong odor. Heat and eat quickly. Keep ventilated

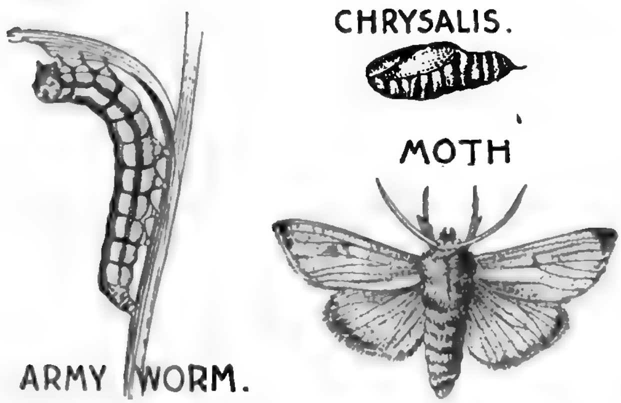

FIG. 123.—1, Army worm, pupa of same; 2, moth into which it changes; 3, chrysalis. This is a cutworm.

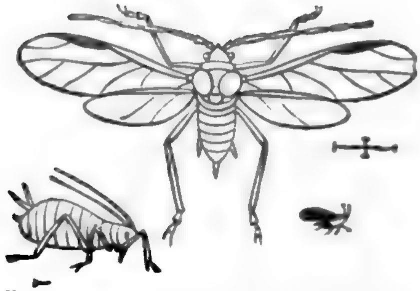

FIG. 124.—Plant lice, half-winged insects. Cross lines and small figure show natural size.

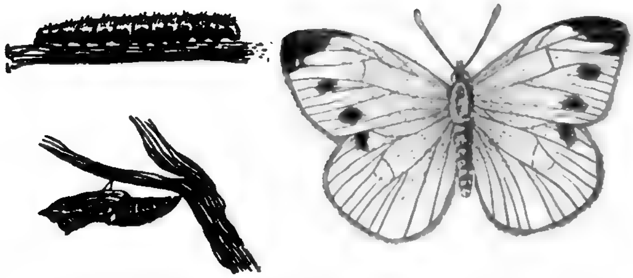

FIG. 125.—The cabbage butterfly. The caterpillar above on the left; the chrysalis below on the left.

FIG. 126.—The insect in the white cocoon is the natural enemy of the tomato worm. Do not destroy it.

INSECTS

VEGETABLES	INSECTS	CONTROL	REMARKS
Asparagus	Beetle	Spray, arsenate of lead	The tender shoots are eaten in the spring and summer
Bean	Bean beetle	Spray, arsenate of lead	Leaves eaten in summer
Bean	Bean weevil	Carbon bisulphide	Handle with care. Fumigate 24 hours in tight room, bin, or vessel. Attacks dry beans
Cabbage	Cabbage lice	Spray, whale oil soap	Spray before the pest becomes numerous on under side of leaves early in summer
Cabbage	Cabbage worm	Plants young, spray arsenate of lead. Plants heading, dust with hellebore	Cabbage heads from inside out, therefore there is little danger from the poison if properly washed off before using
Cabbage	Cut worm	Bran mash mixed with Paris green and molasses to sweeten	Scatter about field. Protect young plants with paper shield about them
Cucumber	Striped beetle	Dust foliage and stem with Land plaster and Paris green	Spray as soon as insects appear in the spring or summer
Corn	Ear worm	Hand pick	Gather before the grub destroys the tip. Enters at tassel end of ear.
Squash	Squash borer	Slit stem near surface soil, remove borer	The first symptom is the wilting of the vine. The wound soon heals
Squash	Black squash bug	Dust underside of foliage with Land plaster and Paris green	Hand-picking is also advisable
Tomato	Flea beetle	Spray with poisoned Bordeaux	Holes are made in the leaves in summer
Tomato	Tomato worm	Spray, arsenate of lead	Hand-picking. But few of the large green worms during the season in most localities

DISEASE

VEGETABLES	DISEASE	CONTROL	REMARKS
Asparagus	Rust	Bordeaux 5–5–50 plus resin-sal soda soap	Plant new bed of clean plants in a clear soil
Bean	Anthracnose	Bordeaux 5–5–50	Brown blotches on bean and stem. Plant disease-resistant varieties
Beet	Leaf spot	Bordeaux mixture	Purple blotches causing leaves to rot. Spraying not very satisfactory
Beet	Scab	Plant in clean soil	Beet has scabby warts on it
Cabbage, Cauliflower & Brussels sprouts	Club root	Treat land with lime six years	Do not plant any of the cabbage family on soil having club root in it. Eliminate weeds belonging to the same family
Celery	Early blight	Remove and burn plants	Yellow spots on foliage. Mostly in seed bed. Plant healthy plants only
Celery	Late blight	Spray, ammoniacal copper carbonate eight applications	Good drainage recommended. Also clean culture. Does not pay to spray on a small scale
Cucumber	Downy mildew	Bordeaux, 5–5–50	Destroy plants having the mildew in the fall
Cucumber	Wilt	No effective remedy	Burn plants
Lettuce	Drop	Clean soil	Plants become soft, slimy mass
Lettuce	Tipburn	No remedy	Caused by rapid loss of moisture. Not a disease
Onion	Mildew	Bordeaux 5–5–50 and resin-sal soda-soap	Spray as soon as disease appears, tops drooping over. Repeat every 10 days
Tomato	Leaf spot	Bordeaux 5–5–50	Burn diseased plants in fall. Spray every two weeks
Turnip	Club root	Same treatment as cabbage	Do not feed diseased turnips to hogs and then put manure on the soil. Spreads disease

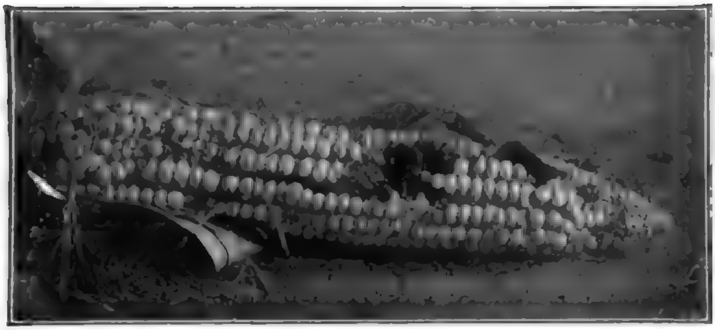

FIG. 127.—Corn worms busily at work. The mother lays her eggs near the silk and her children go into the ear of corn.

The following table shows the temperatures at which the plants mentioned are liable to receive injury from frost. The temperatures are, as nearly as possible, those of the air in contact with the plant itself. Frost usually comes when the sky is clear, the wind dies down at sunset, and the air has a crisp, sharp feeling. Plants may often be saved if given very slight protection — a cover of cheese cloth, branches of trees or even newspapers. In small, sheltered gardens frost may sometimes be warded off by building a smudge fire or by placing shallow pans of water near the plants.

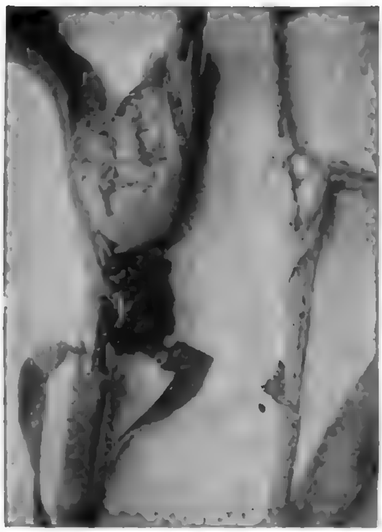

FIG. 128.—Corn smut. Note the black mass of spores under the infested ear. The smut should be cut out and burned before the spores fly.—*Courtesy of Doubleday, Page & Co.*

TEMPERATURES INJURIOUS TO PLANTS

PLANT OR FRUIT	IN BUD	IN BLOSSOM	IN SETTING FRUIT	AT OTHER TIMES
Almonds	28	30	30	28
Apples	27	29	30	26
Apricots	30	31	32	30
Asparagus	29	29	29	26
Bananas	31	31	32	31
Barley	....	29	....	....
Beans	....	31	....	....
Beets	....	....	....	25
Cabbage	....	....	....	15–27
Cantaloupes	32	32	....	30–31
Cauliflower	....	....	....	20–27
Celery	....	....	....	28
Cucumbers	31	31	31	32
Cymlings or squash	31	31	31	30
Flowers*	31	31	31	30
Grapes	31	31	30	28
Grape-fruit	30	31	31	28
Lemons	30	31	31	28
Lettuce	....	....	....	12–28
Mandarins	31	31	31	28
Oats	31	....	....	....
Okra	....	....	....	31
Olives	30	31	31	{18‡ 24§}
Onions	....	....	....	20
Oranges†	30	31	31	{26‡ 29§}
Parsnips	....	....	....	27
Peaches	29	30	30	29
Pears	28	29	29	28
Peas	29	30	30	25
Plums	30	31	31	29
Potatoes, Irish	30	30	30	31
Potatoes, Sweet	31	31	31	31
Prunes	30	31	31	29
Radishes	....	....	....	25
Shrubs, trees, or roses	26–30	28–32	....	30–26
Spinach	....	....	....	21
Strawberries	28	28	28	30
Tangerines	31	31	31	28
Tomatoes	31	31	31	31
Turnips	....	....	....	26
Watermelons	....	....	....	28–31
Wheat	....	31	31	....
Walnuts, English	30	31	31	28

*Depends on variety. †Injured at 2 higher if continued 4–6 hours. ‡Ripe. §Green.

FROST AND TEMPERATURE TABLE

PLACE	ANNUAL TEMPERATURE			KILLING FROST	
	Mean	Max.	Min.	Last in spring	Early fall
Alabama—Birmingham	63	97	13	Mar. 4	Oct. 25
Mobile	66	97	24	Feb. 17	Nov. 19
Montgomery	64	97	19	Mar. 4	Nov. 14
Arizona—Flagstaff	45	92	–18	June 15	Sept. 15
Phœnix	70	112	25	Feb. 18	Dec. 23
Yuma	72	113	29	None	None
Arkansas—Fort Smith	60	96	3	Mar. 28	Nov. 13
Little Rock	61	96	7	Mar. 28	Nov. 13
California—Los Angeles	63	97	32	None	None
San Diego	62	94	35	None	None
San Francisco	56	101	38	Feb. 15	None
Colorado—Denver	50	97	–10	Apr. 30	Sept. 15
Grand Junction	51	99	–15	Apr. 13	Oct. 31
Pueblo	51	98	–13	May 3	Oct. 8
Connecticut—New Haven	48	94	–6	Apr. 20	Oct. 25
Delaware—Newark	51	98	–10	Apr. 23	Oct. 4
Washington, D. C.	53	96	2	Apr. 17	Oct. 7
Florida—Jacksonville	68	97	26	Feb. 18	Nov. 27
Key West	76	93	51	None	None
Tampa	71	95	32	Feb. 18	Nov. 28
Georgia—Atlanta	60	94	12	Mar. 4	Oct. 25
Columbus	65	101	21	Feb. 22	Oct. 25
Toccoa	58	97	12	Apr. 5	Oct. 25
Idaho—Boise	52	104	4	May 5	Oct. 30
Lewiston	45	108	16	Apr. 12	Oct. 30
Pocatello	47	96	–12	May 8	Oct. 15
Illinois—Cairo	57	95	1	Apr. 20	Oct. 20
Chicago	47	94	–15	Apr. 20	Oct. 25
Springfield	50	97	–12	Apr. 20	Oct. 25
Indiana—Bloomington	53	100	–11	Apr. 20	Oct. 20
Indianapolis	51	94	–9	Apr. 20	Oct. 20
South Bend	47	94	–11	May 15	Oct. 1
Indian Territory—Muskogee	59	100	1	May 1	Oct. 15
Iowa—Des Moines	48	94	–18	May 1	Oct. 15
Dubuque	46	94	–23	May 15	Oct. 25
Sioux City	47	96	–21	Apr. 25	Sept. 20
Kansas—Fort Scott	56	100	–11	Apr. 15	Oct. 15
Manhattan	53	102	–16	Apr. 25	Oct. 20
Topeka	53	98	–10	May 1	Oct. 20
Kentucky—Bowling Green	56	99	–3	Apr. 20	Oct. 20
Lexington	54	94	–3	Apr. 15	Oct. 25
Louisville	56	98	–1	Apr. 15	Oct. 25
Louisiana—New Orleans	68	95	27	Feb. 15	Nov. 15
Shreveport	65	97	13	Mar. 5	Nov. 15
Maine—Orono	41	89	–27	June 1	Sept. 15
Portland	43	93	–10	May 2	Sept. 25
Maryland—Baltimore	54	97	2	Apr. 15	Oct. 30
Princess Anne	53	93	0	May 1	Oct. 20
Massachusetts—Boston	48	93	–10	Apr. 20	Oct. 25
Worcester	47	94	–10	May 1	Sept. 25
Michigan—Detroit	47	96	–10	May 1	Oct. 5
Saginaw	45	96	–20	May 10	Sept. 20
Minnesota—Minneapolis	42	92	–33	May 15	Oct. 5
Winnebago	44	92	–30	May 1	Sept. 20
Mississippi—Biloxi	68	98	24	Feb. 15	Nov. 15
Vicksburg	65	94	18	Mar 4	Nov. 15

FROST AND TEMPERATURE TABLE—*Continued*

PLACE	ANNUAL TEMPERATURE			KILLING FROST	
	Mean	Max.	Min.	Last in spring	Early fall
Missouri—Kansas City	53	97	–10	Mar. 30	Oct. 25
St. Louis	55	98	–10	Apr. 20	Oct. 25
Montana—Great Falls	46	97	–25	May 25	Sept. 15
Kalispell	43	94	–10	May 5	Oct. 5
Miles City	45	104	–30	May 20	Sept. 15
Nebraska—Fremont	48	100	–20	May 1	Sept. 15
Lincoln	49	99	–14	Apr. 30	Oct. 15
North Platte	49	99	–10	Apr. 30	Sept. 15
Nevada—Carson City	48	92	–15	May 20	Sept. 15
Winnemucca	48	96	–20	May 25	Sept. 15
New Hampshire—Concord	44	95	–20	Apr. 20	Sept. 30
Plymouth	42	97	–27	June 5	Sept. 10
New Jersey—Cape May	52	91	0	Apr. 20	Oct. 30
Trenton	54	94	0	May 1	Sept. 20
New Mexico—Mesilla Park	60	103	4	May 3	Oct. 20
Santa Fe	49	89	–4	Apr. 30	Oct. 30
New York—Albany	46	97	–25	May 1	Sept. 25
Buffalo	46	89	–8	May 1	Oct. 10
New York	50	95	–5	Apr. 20	Oct. 30
North Carolina—Asheville	53	90	4	Apr. 15	Oct. 15
Charlotte	59	98	14	Apr. 5	Nov. 10
Raleigh	58	99	14	Apr. 20	Oct. 30
North Dakota—Bismarck	39	99	–40	May 15	Sept. 15
Devils Lake	36	96	–40	May 15	Aug. 15
Ohio—Cleveland	47	90	–8	May 1	Oct. 30
Cincinnati	54	96	0	May 5	Oct. 25
Oklahoma—Chandler	65	101	0	May 1	Oct. 25
Stillwater	57	102	3	May 1	Oct. 25
Oregon—Baker City	46	97	0	May 15	Oct. 15
Portland	53	100	24	Mar. 1	Nov. 15
Pennsylvania—Philadelphia	52	96	–2	Apr. 20	Oct. 25
Pittsburg	51	92	–5	Apr. 20	Oct. 10
Rhode Island—Providence	50	97	3	Apr. 20	Oct. 25
South Carolina—Charleston	64	98	23	Feb. 15	Nov. 20
Greenville	55	97	9	Apr. 25	Oct. 25
South Dakota—Pierre	46	105	–20	Apr. 30	Oct. 30
Tennessee—Memphis	60	94	6	Mar. 1	Oct. 15
Nashville	58	97	1	Apr. 5	Oct. 25
Texas—El Paso	63	102	14	Mar. 10	Nov. 10
Galveston	68	91	24	Feb. 1	Dec. 25
Utah—Logan	46	96	–15	May 15	Oct. 15
Salt Lake City	51	98	–5	Apr. 15	Sept. 15
Vermont—Burlington	45	90	–18	May 1	Sept. 15
Northfield	40	89	–30	June 1	Sept. 10
Virginia—Charlottesville	55	97	2	Apr. 20	Oct. 25
Hampton	56	98	11	Apr. 20	Oct. 15
Washington—Tacoma	50	97	22	Mar. 15	Nov. 15
Spokane	48	100	4	Apr. 30	Oct. 30
West Virginia—Elkins	48	90	–9	May 10	Oct. 10
Parkersburg	53	95	–2	Apr. 20	Oct. 15
Wisconsin—Madison	44	90	–25	Apr. 25	Oct. 15
Milwaukee	45	94	–20	Apr. 20	Oct. 20
Wyoming—Cheyenne	44	90	–20	June 1	Sept. 15
Lander	43	90	–28	May 25	Sept. 15

CHAPTER XIII

CHICKENS

BY PROF. WM. C. SANCTUARY, B.Sc.[1]

About the first thing the writer heard on being ushered into this world was the cackle of a laying hen. To many a farmer and farmer's wife it is this same cackling that means mortgage lifting and a profitable business. It is with the object of helping to keep the hens cackling that this chapter is written. The basis for the selection of the subject matter has been the numerous and practical questions asked by farmers and poultrymen.

The farm flocks.—The farm flocks are producing most of the eggs in America. But the farm flock should always be profitable. To be profitable it should be either just large enough to utilize the table and other farm waste or big enough so that the owner will have an object in feeding and housing it carefully and so that the eggs and meat may be marketed advantageously. One hundred birds makes a good farm flock.

The breed.— One of the dual purpose breeds will be the easiest to handle and from which to get winter eggs. In many markets, however, the white egg brings a premium, so that with a little more pains some of the Mediterranean breeds will prove more profitable.

For production from the dual purpose breeds one of the following may be selected: Barred Rocks, Rhode Island Reds or White Wyandottes; from the white egg breeds probably the White Leghorn should be chosen. Ninety per cent of America's hens will be found from among these breeds. In purchasing foundation stock, the best plan is to buy from some nearby poultryman whose flocks can be seen and the performance of which can be verified. The next best method is to purchase stock from some breeder whose birds have done consistently well in a good laying contest. One of the poorest methods is to purchase stock based upon fancy poultry show winnings. These mean but little when the egg basket is considered.

Breeding.—The key to all breeding methods is individual selection and progeny testing. Only the best should be used as

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[1] New York State School of Agriculture, Morrisville, N. Y.

breeders and further their ability to make good should be measured by the performance of their offspring.

The breeding hen should be selected from:

1. Vigorous active birds (see illustration).
2. From hens, that as pullets hatched in April or May, started to lay before Christmas. Mark these with red spiral bands.
3. From hens that lay late into the fall. Mark birds still laying after September 15th with a blue spiral leg band (see *Culling*).
4. From good capacity birds (see illustration and *Culling*).

The breeding male should be selected from:

1. Vigorous birds, preferably "cocks of the walk."
2. Early maturing birds. Birds that feather well and crow early are more likely to be good ones.
3. Good capacity birds (see illustration).

Pure bred stock only should be kept. In a flock of 100 or more birds, new blood will not need to be introduced more often than once in three or four years. In fact, as long as the hatches are good, the production high and the mortality low, new blood should never be brought in. The swapping of males is one of the worst of practices. When new blood is needed, obtain it from the same source as the original stock was purchased. Do not mix strains. One might as well try the crossing of Jerseys and Holsteins. If, on the other hand, the old stock is not up to par, it would be well to purchase some eggs or chicks from a better strain. But the man "from Missouri" will test these new pullets by hatching and treating them in the same way as some of his old line and compare the results. If they prove their superiority in the egg basket he will try mating them among themselves. If they continue to be better than his old line he will continue the new line but will under no circumstances mix them with the old line.

Raising the average production of a flock a dozen eggs per hen by any method means at least $25 additional profit per 100 hens each year. On the average farm where poultry is a side line it will be best to simply maintain the good qualities of a strain that some breeder has built up, by careful selection of the breeding flock as outlined above and by occasionally going back to the same breeder for new blood when it is found advisable.

The "seed-plot" breeding plan, however, offers further opportunities to the farmer who has several hundred hens and who has the time and inclination to better his flock. The first "seed-plot" breeding pen should be made up of a dozen of the best

layers in the flock mated to a vigorous male that has come from a high producer of the same strain. The selection of this male is extremely important as he, alone, transmits half the characters to all of the chicks from this mating. Each bird in the pen must be a good individual regardless of other points. Pedigree must not be worshipped to the neglect of good judgment. Trap-nest these birds during the breeding season, at least, and mark each egg with the layer's number. On the eighteenth day, if the eggs are in an incubator put each hen's eggs in a separate cheese cloth or mosquito-netting bag, or if the eggs are under hens, put one hen's eggs under a single hen. This first mating will be called the 1920 mating, the second year's the 1921 mating, etc.

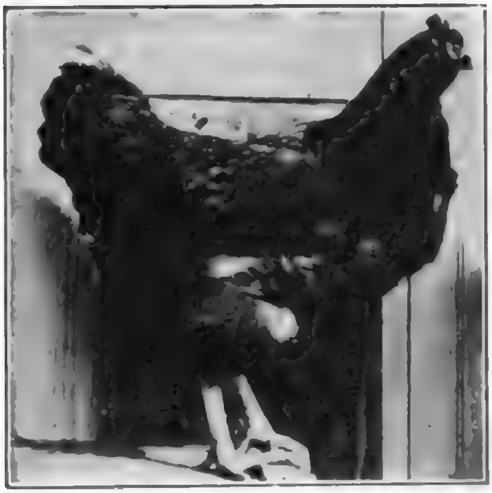


Fig. 129.—Rectangular body deep in the rear.

Toe-punch all the chicks from the first or 1920 mating in the right web of the right foot. Punch chicks from the 1921 mating in the inside web of the right foot, etc. There are fifteen different combinations of toe-punches. This will permanently identify each year's chicks. In addition to the toe-punch it is advisable to at the same time put small pigeon bands about the chicks' legs just close enough so that the chicks will not lose them. Do this when the chicks are taken from the bags. About four

Fig. 130.—A vigorous, active hen.

weeks later, these bands should be removed and placed about the ligament of the wing web close to the "wrist" joint and fastened. At maturity, additional hen-size bands may be put on the legs. Keep records of these marks and numbers. The pullets from these chicks should be put into a pen by themselves and at least a pen egg record kept. If these birds do better than the rest of the pullets from the flock matings that have otherwise been treated the same, progress has been made and the plan should be continued. The cockerels from this 1920 mating, if good individuals, can then be used on the rest of the birds in the flock matings the following Spring. For the second year's, or 1921 "seed-plot" breeding pen, use the same old male with about a dozen of his daughters. Test the pullets from this mating in the same way. If this old male is known to have come from an exceptionally good hen this mating is particularly desirable. The third, or 1922 season, the same original male may be used upon his granddaughters if the 1921 mating has proven successful. A cockerel from the first, or 1920 mating, could be used on these 1921 pullets, or a cockerel from the 1921 mating could be used on the original hens of the first mating. This latter would be particularly desirable if the hens in this first mating were better than the male. Many matings, and the progeny from them, may have to be discarded as breeders and new starts made from the

FIG. 131.—A poor capacity bird and early moulter.

general flock, but one should try many times before discarding this method.

If two or more "seed-plot" pens can be used, many more combinations can be tried and progress made more quickly. The above method is making use of more or less in-breeding, called line-breeding because the mating of too closely related birds is avoided. All of our best breeds of domesticated animals have been perfected and made uniform by line-breeding. It is easily seen that this "seed-plot" method will result in a very uniform flock of birds representing in a short time almost the same blood lines as that of the first "seed-plot" pen. This method necessitates the keeping of the best birds for several years. Exceptional birds should be kept as long as they will breed. The writer has used the above method very successfully.

Fig. 132.—A good capacity cockerel.

Trap-nests present the only correct means of measuring the productive capacity of hens. If traps can be used, the first place should be in the breeding-pens. The breeders in the "seed-plot" pen should be trapped during the mating season. Next, they should be used on some of the more choice pullets during the least busy season of the year to determine their rate of production and to help in the selection of birds to go into special breeding-pens. Birds that will lay from twenty-four to thirty eggs in any one month have great capacity to lay and if, with this capacity, they have inherited ability to start laying early as pullets

and to continue late as hens, and last of all these eggs hatch well, there are no better hens to be had anywhere. There are but very few conditions that will warrant trapping all the birds the entire year.

Culling should be practiced at all times of the year with all the birds, young and old, but the layers are most easily culled during July, August and September. Begin in July and go through the flock every two weeks with a flashlight and cull out all the quitters.

The yellow coloring pigment in a yellow-skinned bird starts to leave different parts of her body in the following order when she begins to lay:

Fig. 133.—A good capacity bird.

1. The vent, very quickly.
2. The eye-ring, quickly.
3. The ear-lobes, less quickly.
4. The beak, in a month or two.
5. The shanks, completely in about four months.

Body changes, other than the loss of coloring matter, also occur as laying progresses and apply to all breeds. The bird that has been laying best will have:

1. A soft, well-developed abdomen and a large moist vent. A sagging abdomen, however, is undesirable, except in very old birds.
2. A soft velvety skin and thin pelvic bones due to loss of fat.
3. A lean, clean-cut head with wattles fitting up close.
4. A bright red comb. The comb expands and contracts directly as the ovaries expand and contract.
5. Good capacity, as measured by length and depth of body. The bird's body should be deeper in the rear than in front (see

illustration). With males the body is usually more shallow in the rear. But the males that have back and breast line most nearly parallel are most likely to transmit the greatest capacity to their daughters.

6. Body lines that appear rectangular, with pronounced angles rather than rounding curves (see illustration).

The quitters and poor layers have just the opposite characters, such as dry, small, puckered vents; hard abdomens, firm skin, shrunken, pale combs; yellow vent, beak, shanks, etc., and shallow, short bodies, indicating lack of capacity.

FEEDING

The laying hen requires in her ration the same elements that she obtains in the spring and early summer when given unlimited range and access to plenty of grain. But she can obtain these foods during these seasons only and if the farmer is to get her to lay profitably during the rest of the year he must supplement what nature fails to supply. The two foods that are largely responsible for the spring lay are the abundance of tender greens and small animal life. These, with grain, is all that is needed to start them laying. When the hot weather sets in, the greens become dry and hard, and many of the worms burrow deep into the soil. These conditions with the hot weather immediately cause the egg yield to drop. As fall approaches more natural laying conditions again are evident in the cooler weather, new, tender greens and another crop of worms. But at this time many birds start to moult and they are going to need these foods to manufacture a new coat and so cannot put this food into the egg basket. This feather-building takes from sixty to ninety days. This is a vacation that all the hens must take. With winter and its cold temperatures, no greens nor animal food, the hen would naturally continue on this vacation until warmer weather again brought nature's natural reproductive season.

The laying ration, therefore, must contain what nature supplies in the spring. This should be then:

1. Animal food in the form of meat scrap or better in the form of sour milk or buttermilk.
2. For best results and to insure good hatches in the spring, green leaf food is necessary. Roots are good but will not take the place of the green leaf elements for good hatches.
3. A mash of ground feeds.
4. A scratch grain made of two or more grains.

5. Oyster shell, grit and charcoal, accessible at all times.
6. An abundance of fresh water.

A good laying ration:

Mash.— Equal parts of meat scrap, corn meal or gluten feed, wheat bran, ground oats, wheat middlings.

Scratch grain.— Equal parts of corn, wheat, oats.

A good mash will contain twenty per cent meat scrap, about twenty per cent wheat bran, about twenty per cent corn or gluten feed and the balance in ground oats, middlings or other available ground feeds that are not very concentrated. Corn, wheat, barley, oats, buckwheat, peas and almost any home grown grain except rye, may be ground and used in the mash. But the mash should always contain wheat bran and meat scrap (if milk or meat is not provided in some other way).

One farmer uses nothing but calf heads and other waste from his farm butchering as the only source of animal food. His birds lay well and his eggs hatch well. As soon as the birds finish one head he gives them another.

Milk will take the place of meat and may be fed, always sour, in pans, all they will drink.

A good scratch grain will be made of at least half corn or wheat, or both. The other half may be made of any grain that can be raised on the farm or bought reasonably, with the exception of rye. Less corn and buckwheat should be fed in the summer.

The method of feeding should be such as to:

1. Induce exercise.
2. Cause the birds to eat the right proportions of mash and grain.

Exercise is induced by feeding as frequently as possible very small amounts of grain during the day in a litter about six inches deep. During the winter, a small pail containing the day's grain allowance may be placed in each pen and a handful scattered each time the attendant goes through the pen. An hour before the birds go to roost the remainder of the day's allowance is scattered in the litter.

The right proportions of mash and grain are maintained by restricting the amount of grain the hens would naturally eat. They prefer the grain to the rather unpalatable dry mash. The following daily amounts of grain for each one hundred hens, of any breed, has given excellent results at the Vineland Contest:

12 pounds during November, December, January, February, March and April.

10 pounds during May and June.
8 pounds during July.
6 pounds during August.
5 pounds during September and October.

This manner of feeding will cause the hens to eat much more mash during the summer and fall when they need it most.

The successful feeding of the chick is one of the most important phases in profitable poultry keeping. Probably there have been more failures in the business through inability to reproduce the flock than from any other cause. For the first forty-eight hours after hatching the chick should have no feed. Then only absolutely clean, sweet feed should be given.

The first day, when the chicks are brought to the hover in the late afternoon, each chick is given a drink of water and, if possible, of sour milk. They are then placed under the hover. Do not chill the chicks. The following mixture, by weight, is next scattered on a clean newspaper:

10 commercial chick grain	1 chick charcoal
5 wheat bran	5 chick grit
5 rolled oats	1 chick bone

Scatter some shredded, tender green food over this. Until it becomes dark do not leave the chicks long to themselves. Continue teaching the chicks to eat and drink, and place the chicks under the hover frequently until they learn to know it as their foster mother. Too much care cannot be taken this first afternoon.

The second day the same mixture may be kept before them on clean newspapers or in small V-shaped troughs. In the middle of the forenoon and afternoon bread or johnny cake, moistened in milk, should be fed; or a mixture in the proportions of a quart of bran and rolled oats, equal parts, with three boiled first-test infertile incubator eggs, including the shell, may be ground together and fed. All moist mixtures should be cleaned up in a few minutes and should be mixed daily. *Do not overfeed.* From the second day on, there should be no chick grain or moist feed in sight except at feeding time.

From the third day on the small chick grains should be fed alone and scattered or buried in the litter, morning, noon and night. Feed only what they will clean up in an hour or two. Continue feeding the grain this way until the chicks are hopper fed. Grit should be accessible. The following dry mash, by weight, should be kept before them in shallow boxes with a one-

half-inch square mesh wire grating resting on top of the feed to prevent wasting:

1 wheat bran	1 middlings
1 rolled oats	½ best sifted meat scrap
1 corn meal	¼ granulated bone meal

A little charcoal

If milk cannot be kept before them to drink, increase the meat scrap to a full part.

At this time the mid-forenoon and mid-afternoon feed may be changed to the above mash, moistened with milk. If milk is kept before them in shallow dishes, with inch-mesh wire netting stretched across the top and bent over the edges, good results may be obtained if no moist feed is given. Greens should be fed at least twice a day until the chicks get onto the ground. *Do not overfeed.*

From the second to the fourth week feed as before, except that one feeding of the moist mash should be discontinued. The rolled oats in the mash may be replaced by sifted ground oats. *Do not overfeed.*

From the fourth to sixth week the mash may be gradually changed so that it contains the regular ground oats and meat scrap. Also begin to mix whole wheat and cracked corn with the chick grain. *Do not overfeed.*

From the sixth week to maturity, the same mash or the regular laying mash may be put in larger hoppers. In one side of the hopper, grain consisting of equal parts of cracked corn and wheat, may be fed to maturity. Where the chicks are getting ample range they should eat about equal parts of mash and grain.

CHICK POINTERS

1. Young chicks are extremely sensitive to temperature changes. Most diarrhœas are caused by chilling.
2. Stunted chicks are worthless chicks. Start culling early.
3. Greater damage is done by over-feeding than by under-feeding.
4. Chicks should have nothing but clean, sweet feed. Feed musty or sour foods to anything but chicks.
5. Chicks should have clean, dry, well-ventilated houses. "Sweating" among half-grown chicks causes more colds than too much fresh air. Apple trees make ideal roosting quarters for the older chicks.

6. **Chicks** should be raised on new land each year. Gape worm and other chick troubles will be largely avoided in this way.
7. **Well** grown chicks are the only kind of chicks that have made good winter layers.

GROWING TABLE FOR CHICKS (*Lewis at Vineland Contest*)

WEIGHT OF 100 CHICKS

WEEK	FED NO MILK		FED MILK	
	American breeds	Leghorns	American breeds	Leghorns
At hatch	8 lbs.	8 lbs.	8 lbs.	8 lbs.
1	10 “	10 “	10 “	12 “
2	13 “	15 “	15 “	16 “
3	21 “	23 “	24 “	28 “
4	30 “	33 “	42 “	45 “
5	41 “	42 “	62 “	68 “
6	49 “	54 “	87 “	92 “
7	65 “	71 “	105 “	112 “
8	78 “	87 “	134 “	135 “
9	93 “	102 “	155 “	150 “
10	108 “	116 “	175 “	165 “
11	129 “	132 “	190 “	173 “
12	140 “	141 “	204 “	177 “
At this time cockerels removed and sold as broilers				
20	338 lbs.	238 lbs.	377 lbs.	304 lbs.
21	360 “	262 “	390 “	315 “
22	370 “	281 “	402 “	323 “
23	381 “	297 “	405 “	329 “
24	385 “	301 “	410 “	335 “

Fattening for market pays even with the old hens in many cases. Four parts of corn meal, one part of low-grade flour and one part of ground oats moistened with nine parts of sour skim milk or buttermilk makes a good crate fattening ration. Birds to be fattened in this way should be starved for twenty-four hours. Then start feeding the mash in small amounts until by the third day they are given what they will clean up in *ten minutes.* Continue for ten days to two weeks. Plymouth Rocks will gain from one to one and one-half pounds in this time. Care must be taken to see that the birds relish each meal. Over-feeding must be avoided.

Breeding stock should not be forced so much for winter egg production. They should be fed a little more grain and less mash; should be made to work more and should have all the

green feed they will eat. If there is a limited amount of green leaf feed, save this for the breeders and particularly for the four weeks just previous to the time when hatching eggs are wanted. Mangels and roots will not take the place of cabbage and other green leaf feeds when hatchable eggs must be had.

HOUSING

Poultry houses are built to keep the hens comfortable. When the birds are fed rations that approximate the natural feed found in the spring and are protected from the storms and excessively low temperatures of winter a profitable egg yield will result. Every poultry house should be built to maintain these conditions:

1. *Dryness,* which depends largely upon proper ventilation, and the distance of the floor above the outside ground level. The hen gives off the body waste moisture through the breath and not through the urine as other animals do. Therefore the hen requires more ventilation as compared with the other domestic animals.

2. *Sunlight* is nature's disinfectant and comfort tonic.

3. *Protection from excessive heat or cold.*—In winter the average man will confine his birds too closely. Good ventilation is obtained only at the expense of some heat, so that the skillful poultryman is the one who is most successful in this compromise. A bird with a frosted comb is not a laying bird but hens that are not too closely confined in the fall will be able to stand much lower temperatures than those which have been shut up tightly at the first cold snap.

A laying house that has the features necessary to maintain comfortable conditions in a climate like that of Central New York is shown in the illustration. Its dimensions are, for each unit of one hundred hens, twenty feet deep by eighteen feet wide, five feet high in the rear and nine feet high in the front.

At "A" the floor level will be noticed.

"B" and "B′" are two nine-light, eight by ten-inch pane windows that tip back in Sheringham valves, permitting of adjustment according to weather conditions. In the summer and on nice days in winter, one or all may be lifted out of their places. All six openings, in each pen, are letting in light.

"C" and "C′" are two burlap screens which prevent excessive drafts when strong winds are blowing and prevent the snow from entering. Most of the time, one or more of the upper windows should be out of the valves even in the winter.

"D" is the summer ventilator.

"E" is the emergency curtain made of burlap and hung at a distance from the dropping board equal to the width of and down to the same level as the dropping board. On many still zero night this curtain can be lowered and the rest of the windows kept open. This makes it much easier to keep the rest of the pen dry, gives the birds much purer air and yet protects them from the extreme cold.

"F" is a ceiling which makes an air space between the birds

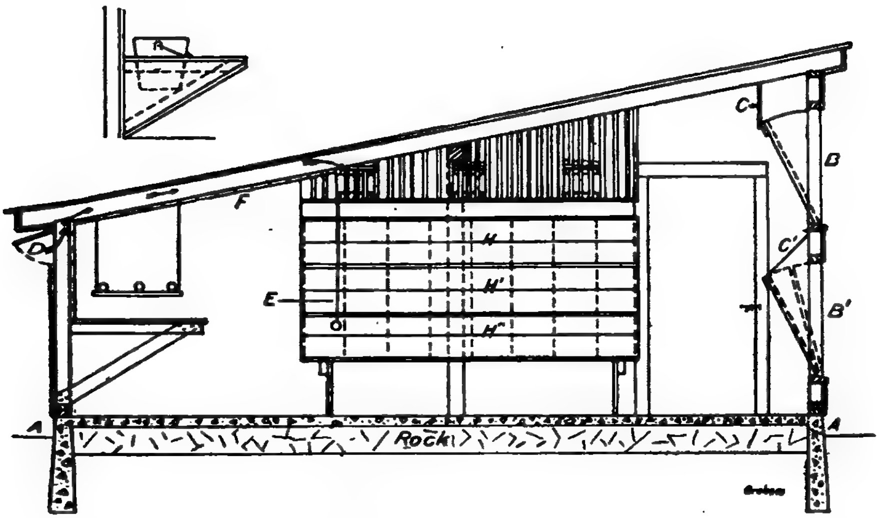


FIG. 134.—Laying house.

and the cold roof and also prevents the draft that would result when the summer ventilator is open.

Equipment for the laying house is shown in the illustration, except for the mash hopper. "H," "H′," and "H″" represent three tiers of nests above which are the broody coops. The nests should be twelve inches by fourteen inches by fourteen inches high. The openings should be to the rear. The top of the bottom nests furnishes the bottom for the next tier, etc. The nests as all other equipment should be easily removable for housecleaning and in case the mites should get into the house. Most houses are supplied with mash hoppers that furnish about four feet of opening for one hundred birds. Probably double this amount would enable the weaker birds to greatly improve their egg record. The water pail rack shown in the illustration can be improved by enclosing with boards and filling with straw which will prevent the water from freezing so quickly. The mash hop-

per and water paid can be placed on the wall opposite to the nests.

A practical colony house is shown in the illustration. Its dimensions are ten by ten feet, five feet high in the rear and seven feet in the front. The windows, in Sheringham valves, should be placed above the center of the front to prevent drafts. The back ventilator is most essential for a colony house.

Artificial lights have proven very successful in increasing winter eggs. The year's total is not so greatly increased but

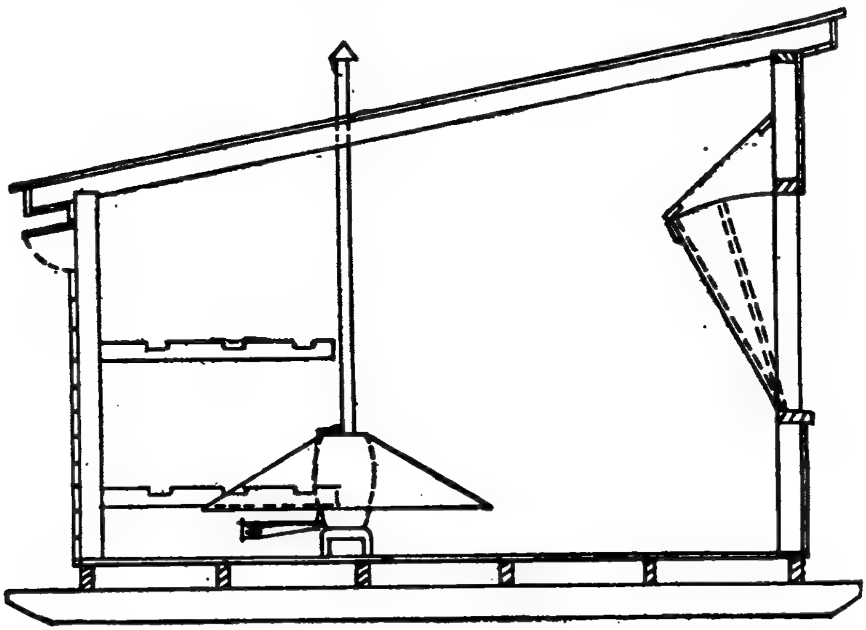


FIG. 135.—Colony house.

the increased total income due to the high-priced winter eggs makes the installment of lights a fine investment. Unless carefully managed, lights may lessen the hatchability of the eggs, so that beyond maintaining a twelve-hour day they should not be used for the breeders. Making the day about fourteen hours long seems to give best results for the layers. Keeping the lights on from dusk to about eight P. M. is about right. On many farms where electricity is used, putting on the lights at chore time in the morning and shutting them off after supper will be found convenient. With lights, a slight decrease in production may be expected in April and May, but this happens when eggs are cheapest. Gasoline lanterns have been used

successfully where electricity or gas is not to be had. With electricity a dimming arrangement should be installed to allow the birds a chance to get back on the roosts. A sixty watt lamp is about right for a one hundred hen unit (see diagram for an alarm clock wiring system).

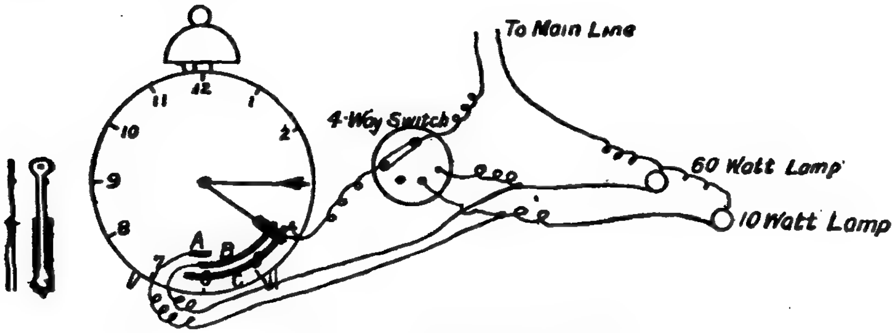


FIG. 136.—Automatic lighting switch.

SANITATION

Cleanliness makes for comfort and prevents the spread of disease. Dead birds should be buried deeply or burned. They should not be put on the manure pile to be drawn out on the farm where a colony of chicks may later contract the same trouble that caused the death of the first birds. In winter a barrel may be used in which to keep the dead birds. Keep the bodies covered with ashes or earth until spring permits burial.

At least one thorough house cleaning should be made in September. All nests, dropping boards, and other equipment should be removed from the house, disinfected and allowed to sun. The rest of the house should be scrubbed with a broom and be sprayed with a good disinfectant.

A good home-made disinfectant is recommended by the Maine Station. This is made from "Commercial Cresol" and may be ordered from a drug store.

"Use care in handling the Commercial Cresol as it is very strong and burns severely. This is the formula: Measure out three and one-fifth quarts of raw linseed oil in a four or five gallon crock; then weigh out in a dish 1 pound six ounces of commercial lye or Babbitt's potash. Dissolve this lye in as little water as will completely dissolve it. Start with half pint of water, and if this will not dissolve all the lye, add more water slowly.

"Let this stand for at least three hours until the lye is completely dissolved and the solution is cold; then add the *cold* lye solution very slowly to the linseed oil, stirring constantly. Not less than five minutes should be taken for the adding of this solution of lye to the oil. Continue stirring until the solution is like soft soap. This ought not to take more than a half hour. Now add slowly, while stirring, the eight and one-half quarts of Commercial Cresol. This makes a stock solution that will mix with water in any proportion." Two or three tablespoons to a gallon of water for disinfecting and about twice that for mites.

DISEASES

Prevention and isolation are the two common practices to be recommended supplemented by individual treatment only in cases of valuable breeding birds, immediate removal of causes and isolation of individuals are the two best remedies. The most common troubles are those of the bowels and when general flock treatment is needed epsom salts or castor oil will help either diarrhœa or constipation. Use one teaspoon of salts to a bird. Most individual cases should be given the salts or oil and then only green food and water for a week or so. As the bird improves it can be worked back to the regular ration.

Bumblefoot, abscess on bottom of foot. *Cause:* Jumping down onto hard floors. *Treatment:* Open, remove pus, clean with peroxide, fill with salve, bandage.

Canker, patches in mouth and on tongue. *Cause:* Associated with roup. *Treatment:* See Roup.

Catarrh and colds, sneezing and watery eyes. *Cause:* Dampness, poor ventilation, drafts. *Treatment:* Remove cause; put birds in warm, dry place, try starvation-green-food treatment suggested above; clean nose passages by dipping head into two per cent disinfecting solution, finish with sweet oil on affected parts. Colds almost always indicate bad housing conditions.

Chicken-pox, red-brown wart-like ulcers on head and comb. *Cause:* Often associated with roup. *Treatment:* Remove warts, treat with disinfectant and finish with carbolated salve.

Constipation.—*Cause:* Lack of exercise and green food. *Treatment:* Change conditions, use salts.

Cholera, not common, bright greenish-yellow diarrhœa, inflamed intestines. *Cause:* Specific germs. *Treatment:* Remove sick birds and kill them, clean and disinfect quarters and yards, plow latter, watch remaining birds and kill any that show symp-

toms. Market all birds left in flock where outbreak occurred, if necessary. Strenuous measures necessary.

Diarrhœa, dropping off color and offensive. *Cause:* Bad feed or water, mild poisoning. *Treatment:* Remove cause, give physic, put charcoal in mash. Acute form is known as dysentery.

Diphtheria.—A very contagious disease which spreads rapidly. Symptoms, yellowish ulcers on the tongue, mouth, throat, and windpipe. Remove affected birds from flock and paint ulcers with tincture iodin, apply glycerin to soften crusts. Add a little hyposulphate of soda to drinking water.

Egg bound.—*Cause:* Abnormal eggs or weakened oviduct. *Treatment:* Soften vent and interior with sweet oil, hold vent over pail of steaming water, then put back on nest. Careful manipulation of parts and egg may be tried.

Favus or white comb, grayish white spots on comb. *Treatment:* Remove and paint with iodine.

Feather eating, more common with chicks. *Cause:* Poorly balanced ration, too closely confined, no exercise. *Treatment:* Correct conditions.

Frozen head parts.—*Treatment:* Ointment of five parts vaseline, two parts glycerine, and one part of turpentine.

Leg weakness, loss of use of legs. *Cause:* Too much fat-forming food, lack of ash. With chicks, too hot floors, confined to colony house too long. Correct causes, increase green food.

Limberneck, neck limp, nervous trouble, from intestinal worms, indigestion, or poisoning from bad food. Two to three teaspoons of turpentine, if due to worms. Remove cause.

Liver troubles, birds dumpish, black combs, yellow diarrhœa, liver enlarged, shrunken, marbled. *Cause:* Too concentrated a diet, not enough exercise. *Treatment:* More exercise and green food. Correct ration if too rich.

Pip.—The result of a disease in which there has been ulceration of the tongue or other parts of the mouth. Wash the mouth frequently with water in which is dissolved one ounce of either boracic acid or chlorate of potash.

Roup, cartarrh symptoms with cheesy matter and cankers, swollen eyes, offensive odor. *Cause:* same as for colds with addition of germs. Very contagious. *Treatment:* Isolate sick birds, mark with white spiral leg bands, keep in pen by themselves and sell at end of season. Disinfect quarters. Pens must be made dry.

Scaley leg, rough scales caused by a leg mite. *Treatment:* Dip shanks, not feathers, into a solution of equal parts of kerosene and raw linseed oil.

Tuberculosis, rather common, general dumpishness, with increasing thinness, a bright eye and ravenous appetite. Pale yellow, hard, small bunches on spleen, liver and intestines are post-mortem indications. *Cause,* specific germ. Is contagious and strenuous measures must be taken to eradicate it. Kill sick individuals. Raise new flock on new ground. Disinfect houses and yards. Never let old birds come in contact with young.

Diarrhœa, white or any color, usually from chilling or bad feeding. *Treatment:* Get after causes. Boiled rice, mild physic. Sour skim milk is good preventative.

Bacillary white diarrhœa, *many deaths in first six days,* diarrhœa not unlike ordinary. *Cause,* a specific germ laid in the egg by mother hen. *Treatment:* No cure. Never breed from flock in which this disease has been discovered. Use strenuous preventive measures. If in small flock, get rid of it and disinfect.

Coccidiosis, similar to bacillary white diarrhœa. *Cause:* A specific germ. Is more apt to attack chicks later in life than is bacillary diarrhœa. *Treatment:* No cure. Isolate, disinfect and raise other chicks on new ground.

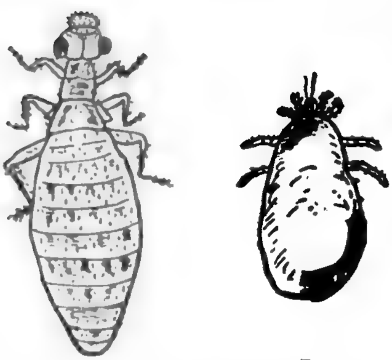
Gapes, Y-shaped worms in windpipe. *Treatment:* Remove with two horse hairs tied at the ends in a knot. Isolate and raise new chicks on new ground.

Aspergilosis, chicks sleepy, breathing rapid, diarrhœa. *Cause:* Mold growth in lungs of chicks from moldy litter. Post mortem, find small yellow bunches in lungs or lungs inflamed. *Treatment:* No cure. Isolate, remove cause, bury dead chicks.

NOTE.—Material for diseases freely drawn from Maine Station Bulleton No. 398-12-10.

VERMIN

Lice.—Rub into the skin of the birds just beneath the vent and under the wings ointment as large as a pea made from equal parts of blue ointment and vaseline. This is effective for six months. It is poisonous.



A B

FIG. 137.—*A,* Louse; *B,* red mite.

Mites are about one-fourth to one-half as large as lice (see illustration). They live in cracks during the day and breed in filth. Mites go on the hens at night and, unlike lice, are blood-suckers. The presence of mites is quickly detected by the presence of gray mat-

ter near cracks. Spray thoroughly, driving stream deep into every crack within several feet of where the mites are found. Repeat in a week to get the next hatch. If this does not finish them, remove all the equipment and do the job still more thoroughly. A five per cent solution of the stock cresol recipe is effective. Mites and good egg production are never found in the same pen.

INCUBATION

A good incubator will prove to be the most economical method of hatching eggs for most. The machine should preferably be one of the standard hot-air machines, provided with a bimetallic thermostat if future trouble would be avoided.

INCUBATOR POINTERS

1. The best place for the incubator is a well-ventilated cellar.
2. Thoroughly clean and disinfect machine before each hatch.
3. Test thermometers.
4. Run machine empty for two days.
5. Do not disturb eggs for two days after placing.
6. Turn eggs and cool twice daily before attending lamps.
7. Cool eggs until they begin to feel cool when placed near eye.
8. Keep lamp free of oil, and shape of flame round.
9. Test eggs at end of first and second week.
10. Save infertile first eggs to boil for chicks.
11. Do not disturb eggs after eighteenth day.
12. Sprinkle eggs daily with warm water from seventh day until first egg pips.
13. Never help chicks out of shell. Start culling here.
14. Leave chicks in machine forty-eight hours before putting in brooders.

BROODING THE CHICKS

The brooder stove and colony house (see illustration) make the most practical equipment for brooding one hundred or more chicks.

The hover temperature should be about ninety-five degrees the first week and should be gradually lowered about five degrees each week to about seventy-five degrees where it should remain until the chicks are weaned. The action of the chicks makes the best thermometer. Chicks well spread out near the edge of the hover indicate a correct temperature. Sand and shavings make

the best litter. At first the chicks should be confined to a small area by means of a circle of wire netting. This should be gradually enlarged until by the third or fourth day, they are having the run of the house. When a week old, they should be allowed to go outside on moist ground, at first only in a small place

FIG. 138.—Position of knife to cut veins.

fenced in near the door. Gradually enlarge this and give them unlimited range as soon as conditions permit.

KEEPING EGGS AND PICKING POULTRY

Waterglass eggs are cheap eggs in the fall and winter. A five gallon crock will hold a crate of eggs. Take only freshly gathered eggs laid in April or May; place them flatwise in the bottom row and on the small ends for the other rows until crock is filled.

To the eggs as each layer is put in add the mixture of one part of waterglass and ten parts of distilled water. Cover crock and put in cool place. The eggs will keep indefinitely.

Dry-picked poultry is required in many markets. Note diagram for place to cut the jugular vein arch. Note also carefully the skull showing the place where the point of the knife must penetrate a small portion of the brain. The knife is first thrust up through the slit in the roof of the mouth to the left of the middle bone and toward the eye cavity. Then the knife must be redirected toward the center of the head and to the brain

FIG. 139.—Knife piercing brain in stunning.

through the optic nerve opening. To do this the handle of the knife must be pressing against the upper beak as shown at "X" in diagram. The vein is first cut, then the bird is immediately stunned. Picking must follow rapidly. If a good stun has been made some of the feathers will start dropping off immediately.

DUCKS

Pekins make a satisfactory meat breed, particularly for sections like Long Island, which are near a market that demands a heavy duck.

Indian Runners are satisfactory for the Middle West and other sections where the markets demand a medium weight duck. The Runners are also very good layers; some flocks, under good

management, laying two hundred eggs per bird per year. As Runners lay a larger egg than a hen and which markets at the same or higher price, the Runner duck should be raised more extensively.

Young ducklings do not require as much heat nor for so long as chicks, but they must have dry quarters and plenty of ventilation. They should not be allowed to swim until they get their breast feathers and then only those which are to be kept for breeders. Plenty of drinking water and shade must be provided. Bread crumbs, hard boiled eggs with tender greens are good for the first few days. Duck food should be largely soft food. To market Pekins at ten weeks of age, feed a mash four times a day made of about ten per cent meat scrap, forty per cent corn meal, fifty per cent bran and middlings. Feed this up to the last two weeks. Then finish on a mash containing about 15 per cent meat scrap, seventy-five per cent corn meal and ten per cent bran. The Runners may be fed in much the same way as the Pekins. A regular hen mash with a feeding once a day of hard grains may be used for the mature birds for egg production.

GEESE

Geese depend upon grass and good pasturage for the greater part of their food. Because of this fact more geese might well be raised. In breeding mate one gander to two or three geese and do this in the fall. In the spring prepare secretive nests in out-of-the-way places for the geese to lay and incubate their eggs. Hens may be used to incubate the first eggs and the geese to hatch the later clutches. Keep the young away from the water as in the case of the duckling. The gosling may be fed in the same way as the duckling. When about eight weeks old they may be fattened for market, weighing then about twelve to fifteen pounds, or kept until fall. Fatten as for ducks, having plenty of green food, grit and water accessible. Feed the mature geese grain night and morning. In plucking geese a good method is to scald, wrap in a burlap bag for five minutes and repeat.

TURKEYS

Turkeys seem to do best in the more sparsely settled sections where they can have unlimited range over fields and woods without troubling neighbors. The mature turkeys should be kept in dry, well-ventilated but draft-free houses. Except during the winter, let the turkeys range freely, feeding a little wheat, barley

and oats in the afternoon. In the winter corn and buckwheat may be added and plenty of greens should be fed. Cabbage is excellent. Especial care should be taken not to overfeed turkeys, old or young.

The mother turkey chooses her nest in the early spring, beginning to lay in March or April. The method of raising the youngsters is very practically described by Miss Sara A. Little in the *American Poultry Advocate,* extracts of which here follow: "From three to six hens may be safely bred to each tom. During incubation turkey and hens should be well dusted with insect powder each week. When hatched annoint each poult on the head and around the vent with softened lard, only using a very little. A box two yards long, a yard deep and a yard high makes a fine coop. Cover the bottom of the box with dry sand or sifted coal ashes. Supply with water in a small fountain and with little chick grit in some handy receptacle and then build a portable detaining yard by staking foot-wide twelve-foot boards at each end of the front of the coop, connecting them at the other end by a similar board the length of the coop.

"When the poults are hatched and dry, remove them in a warmly lined basket to the kitchen stove and take the turkey hen to a quiet room where she should be given shelled corn and water. In about an hour she may be taken to the coop, which should be installed some distance from the haunts of other poultry, and the youngsters given to her. Care must be taken not to frighten her, as some turkeys get much excited when hatching and getting settled with their young. The little fellows will need no food for forty-eight hours, and then the principal thing to learn is not to feed them too much. Once in three hours is none too often to feed them, but they must have very little at each feed. Bread soaked in milk is my first resort, but it should be squeezed dry. Finely chopped leaves from onions and dandelions should be given them with their food. Turkeys need close attention. They must be kept dry. Their quarters must be cleaned and well aired. They must have plenty of fresh water, well guarded, so they cannot get wet when drinking."

"I usually keep the hen cooped for two weeks or more until the little birds seem strong. Then the hen is liberated with the little folks, when the grass is dry in the forenoon. She should be watched so she will not wander too far, and returned to the coop not later than four P. M. and shut in, though the poults need not be housed till later. I shut them in closely at night, making sure they cannot escape."

PIGEONS

Squab raising on a large scale is a prosperous times business. As a side line on the farm pigeons are often profitable. The foundation stock should be good squab Homers. These will raise eight pairs of squabs per year under good conditions. Two nests for each pair will be necessary. Unmated birds should not be kept as they cause trouble. Where birds are confined, cracked corn should be accessible in hoppers. A mixture of red wheat, Canada field peas, Kaffir corn, hulled oats and hemp seed is fed twice a day on the floor. Culled peanuts are also sometimes used. Have dry, clean quarters. Have a box of tobacco stems accessible for nests and to keep down lice.

CHAPTER XIV

THE HORSE

By Prof. W. M. Harper, M.S.[1]

The United States stands among the first nations in the number and quality of its horses. Possibly Europe and the British Isles lead in draft horses, particularly in quality, but the United States leads, and by long odds, in the production of trotters and saddlers as well as in work horses and mules. There are about one hundred million horses in the world, of which approximately one-fifth — the Thirteenth Census giving the number as 23,015,902 — are in our country. Of all the mules in the world, approximately one-half are in our country, according to the census the exact number being 4,480,140. These animals represent vast wealth and unrecorded power.

TYPES AND BREEDS OF HORSES

There are three types of horses: Draft, coach, and light — to which may be added the pony type. Each of these types is distinct as the form or conformation best adapted to one type is different from that of the other. There are a number of breeds within each of these types.

Breeds of the light type.— While of the same general form, the light breeds of horses vary somewhat in conformation, depending on the purpose for which they are adapted. In general conformation, however, the breeds of the light type are rather tall, the legs long, the distance from the knee to the withers and from the hock to the hip is great, the form somewhat narrow and often rather angular, with cleancut features throughout.

Thoroughbred.— This is the running racehorse and is of English origin. This breed is very popular among English sportsmen. Indeed, it was the Englishman's love for the race that resulted in the development of the breed. As early as the thirteenth century the English were importing superior animals to improve their horse stock. These animals came from Rome, Spain and the Orient, especially Arabia and Barbary. However,

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the thoroughbred has been bred without stain of alien blood for more than a century and subjected to the most rigorous system of selection for strength and staying power by the test of performance on the turf.

In conformation the thoroughbred represents the speed type in the extreme, being upstanding, clean-cut and lean. The head is refined and clean featured, shoulders sloping, chest deep, croup long, and the quarters strongly muscled exhibiting great driving power. The lower legs are clean with tendons well

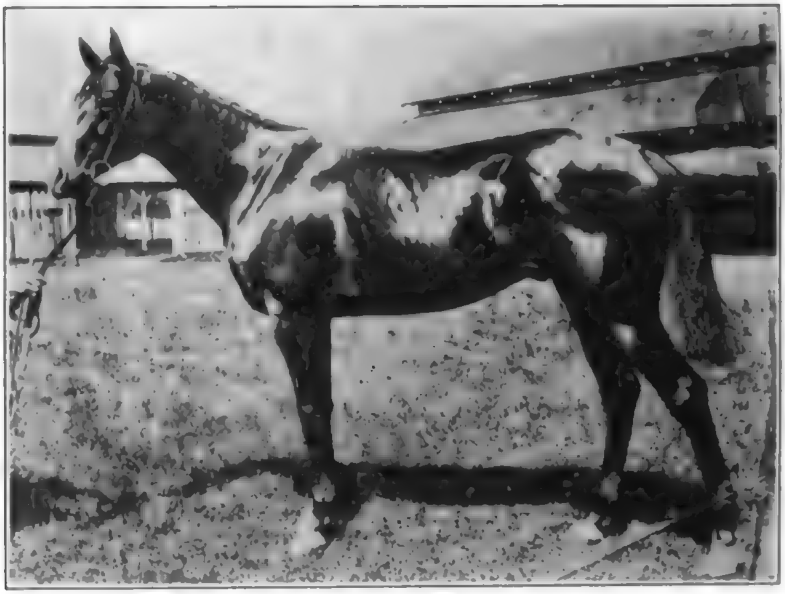

Fig. 140.— Thoroughbred, light, lithe, and agile, a good type for speed.

detached, indicative of substance. While all colors are occasionally found, bay and chestnut are the more common. Typical thoroughbreds weigh about one thousand pounds and they stand from fifteen to sixteen hands high.

Thoroughbreds were imported to the United States early in the eighteenth century, first to Virginia, where they became very popular. In subsequent years, this popularity extended throughout eastern and southern States, where racing was held in high favor. In more recent years, however, this popularity has waned to a very marked degree because of the restrictions put upon racing.

Arabian.— This breed is a native of Arabia and is noted for its beauty, stylish action, stamina, and endurance. In the main,

it was developed in the desert region and is the result of its environment. For centuries the Orient has been noted for the quality of its horses and much of the infused blood of our modern breeds came from there. England, France and Germany began the importations at a very early period. The best Arabian horses are to be found among the migratory Bedouin tribes, of which the two most powerful groups are the Shammer race of the north and the Anezah in the south, the latter having the best horses.

In conformation the Arabian is more symmetrical than the thoroughbred, the head is neater, body shorter, ribs more curved, and the legs not so long. While the Arabian is more stylish in the carriage of the head, neck and tail, and while he possesses great stamina and endurance, he is not nearly the equal of the thoroughbred for speed.

American saddler.— This breed originated in the United States and was the outgrowth of necessity. Before the establishment of roads, traffic was by trail through the forests; and during much of the year the only means of travel was by horseback. This breed was more popular in the southern States and in fact so much of the breeding has been accomplished in Kentucky that the breed is often spoken of as the Kentucky saddle horse. Easy-going thoroughbreds were used in the native stock to improve the saddle horse.

The American saddler is more stylish in carriage of head and arch of neck and tail, as well as in general symmetry, than is the thoroughbred. The shoulders and pasterns are sloping, long and springy, thus favoring an easy gait. The height and weight excels that of the thoroughbred.

The gaits of the saddle horse are distinctive and the breed is divided into classes according to the number of gaits, the more common of which is the "three gaited," or walk-trot-canter horse.

Standard bred.— This breed includes both trotters and pacers. It is of American origin and is the result of the American's love for driving a race much as the thoroughbred for the Englishman's love for riding. The breed is of comparatively recent origin with foundation animals traceable to the thoroughbred. Improvement was obtained for the most part much as in the case of the English thoroughbred, by a rigorous system of selection for speed and endurance by the test of performance upon the race track.

There are several notable families of standard bred horses of

which the more important are Hambletonians, descending from Hambletonian 10, Mambrinos from Mambrino Chief, Clays from Henry Clay, Hals from Tom Hall, and the Morgans from Justin Morgan, the latter of which is now classed as a separate breed.

In conformation the standard bred tends to be angular, the muscles and joints prominent, and the ribs more or less noticeable, with rear ribs longer, giving a straighter underline than in

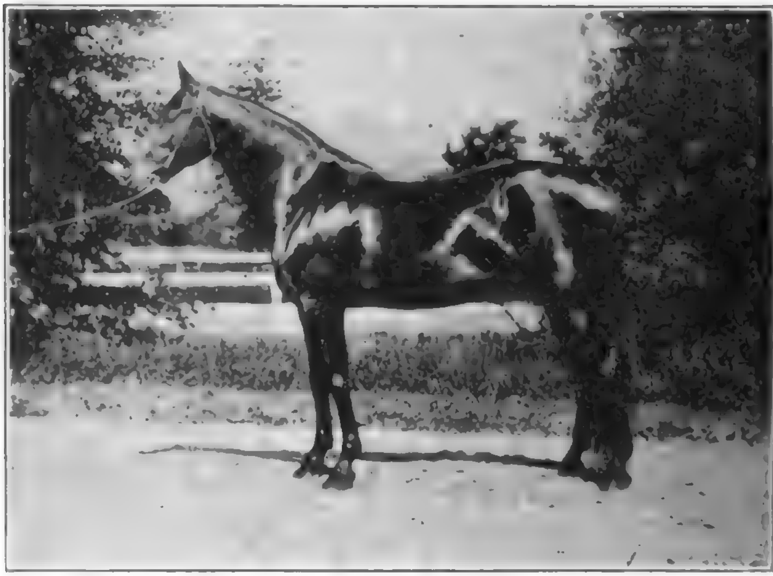

FIG. 141.—Standard breed; a good type from which to breed driving horses.

the thoroughbred. The standard bred is larger, averaging one thousand one hundred pounds in weight and possibly sixteen hands in height. All colors are found, but bays, blacks, and browns are the most common.

This being America's principal racehorse, speed at the trot and pace is the major requirement. The action must be true, varying neither to the right nor the left. Long-reaching knee and hock action with the feet picked up smartly is most essential.

Breeds of the coach type.— The breeds of coach horses are useful for stylish action and carriage or coach work. They owe their origin and improvement, in the main, to the thoroughbred and Arabian. These two breeds did much to increase the speed and improve the action, as well as to increase the endurance of the coach breeds.

Hackney.— This breed of coach horses originated in England and is noted for its stylish and high action. Improvement dates

back to the eighteenth century when the breed was valued for its long and strong action at the trot. At the present time, however, it is the stylish, attractive and often flashy action of the knees and hocks, and not speed, that is important, as this breed of horses is in demand for fashionable equipment. This breed is popular in America.

The hackney is more blocky in form than any other coach breed, has an intelligent head, neat neck, strong back, short leg,

FIG. 142.—Hackney; symmetrical and stylish.

and is powerfully built. The weight will average one thousand one hundred pounds and the height fifteen and one-half hands. The color is chestnut.

French coach.—This breed is of French origin where it is known as demi-sang, meaning half-blood. This name was formerly applied to the offspring of a cross between the thoroughbred and the Norman draft horse, hence the origin of the French name as well as of the breed.

In form this breed is not so smooth or symmetrical as the hackney. It is larger, averaging one thousand two hundred pounds in weight and sixteen hands in height. The bone is larger and the muscling more powerful. The action, especially at the trot, is longer, rather than high and flashy, as in the hackney. Bay, brown and chestnut are the more common colors. This breed finds favor in America where a large and rather active horse is in demand.

German coach.— This breed originated in Germany and varies widely in size and conformation. The breed assumes different names in the more important horse-breeding States. Thus we have the Oldenburg horse, Hanoverian horse, Trakehnen or East Prussian horse and the like.

In form the German coach horse lacks the symmetry of the hackney and is more rugged, with the action at the walk and

FIG. 143.—Percheron stallion; America's most popular draft horse.

trot longer but lacking in style. The weight varies from one thousand three hundred pounds to one thousand five hundred pounds and the height from sixteen hands to seventeen hands. Color varies, with black, brown and chestnut most common. This breed has not found a large following in America.

Breeds of the draft type.— The breeds of this type are in striking contrast to those of the light type. The drafters are low set, blocky and short in the leg. Here weight is important in order to pull heavy loads. Hence, to be classed as a draft horse, he must weigh at least one thousand five hundred pounds.

Percheron.— This breed originated in France, particularly in the region of LaPerche, hence the name Percheron. The natural conditions in France were such as to favor the development of ponderous drafters — an agreeable climate, fertile soil with abundant forage. The native horse, though ponderous, lacked in quality and action, both essential to efficient draft horses. The Oriental horse played an important part in improving such deficiencies. Large numbers of eastern horses found their way into France and Germany as early as the eighth century and there was direct introduction of Oriental blood as late as 1820, when Godolphin and Gallipoli were purchased for the horse-breeding farm at LePin. These horses were gray and no doubt had much to do in developing the gray color of the Percheron. The general effect of this Oriental blood has been to improve the quality, action and style.

For more than two centuries the French government has given material aid to horse-breeding. At present there are three classes of breeding horses in France. First, government owned; second, government subsidized, the owners of such receiving an annual bonus from the Minister of Agriculture; and third, government approved. This close supervision on the part of the government has done much to improve the Percheron horse.

In conformation the Percheron is massive. The head, though large, is cleancut, the neck well crested, shoulders sloping, chest broad and deep, loins broad and well-muscled with the quarters broad and powerful. The pasterns are sloping, feet good size, while the action is true and perhaps second to none among draft horses. The weight varies from one thousand eight hundred pounds to two thousand two hundred pounds, the height sixteen hands to seventeen hands. The more common colors are black and gray. Because of the general excellency of the Percheron, it is the most important breed of draft horse in America.

French draft.— As the name would indicate, this breed is of French origin. The history and description is practically the same as that of the Percheron. This similarity often results in confusion and it is important to remember that French Draft horses cannot be registered in the Percheron Stud Book of America.

Belgian.— This breed of draft horses originated in Belgium, a country fully as noted as France for the size and quality of its horses. The methods employed by the two countries are much the same. Possibly there has not been as much oriental blood introduced to Belgium, though the Belgian horses are as refined

as the Percheron due to the interest and effort of the individual breeder.

In form, the Belgian is the most compact, having a maximum weight for its size. No breed in proportion to its size shows as much body girth. The muscling is powerful throughout. The action is inferior to that of the Percheron because of the more massive conformation. The weight varies from eighteen hundred pounds to twenty-two hundred pounds, the height from six-

Fig. 144.—Belgian; the type that gets low, massive work horses.

teen hands to seventeen hands. The more common colors are bay, black and brown. The Belgian is very popular in America.

Clydesdale.— This breed originated in the valley of the Clyde River in Scotland, hence the name. The valley of the Clyde has long been known for powerful farm horses of superior size and strength. Improvement was due to the efforts and methods of the breeders and to importation of draft horses from England by Scotch cattle dealers. This new blood served to improve the quality and increase the size of the native stock. Upon this foundation, the modern Clydesdale was reared, the result of individual initiative on the part of the horse breeders.

The size and form compares favorably with the Percheron, but the Clydesdale possesses distinctive features. Thus the back

of the legs below the knees and hock grows an abundance of long hair called the "feather;" the color is usually bay and the characteristic markings are a white blaze on the face and one or more white feet; the action is not surpassed. Because of its good action, this breed is fairly popular in America, though the color and the feather are more or less objectionable.

Shire.— This breed is of English origin and is the outgrowth

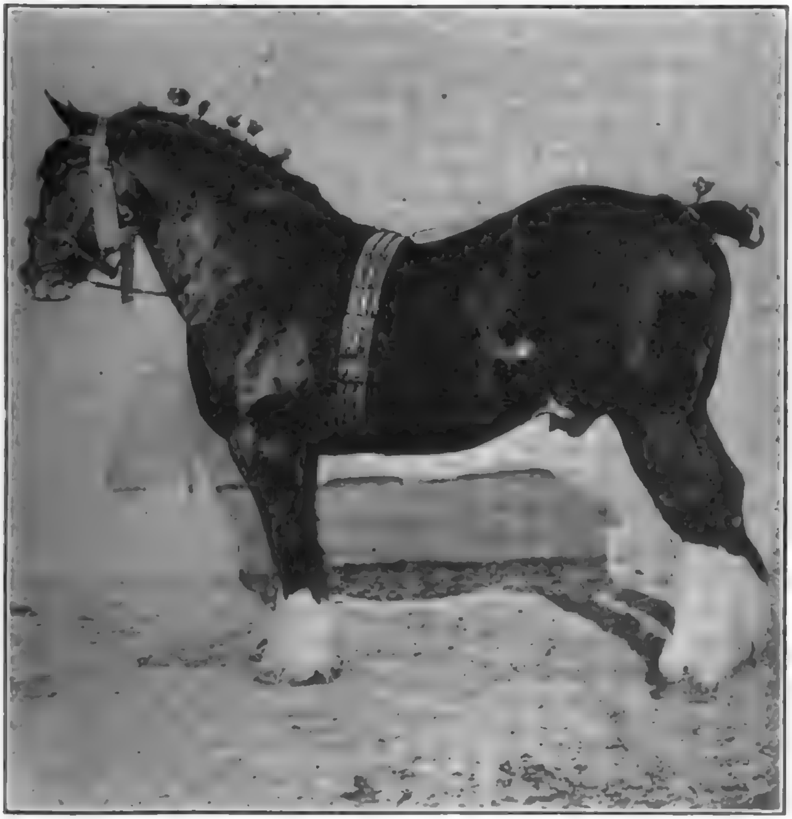

FIG. 145.— Shire, noted for his power and rapid walk.

of England's attempts to produce a ponderous horse useful for war. One of the early improvers of this breed was Robert Bakewell, who did much to stimulate interest in the establishment of modern breeds of farm animals. The breed owes its excellency to English breeders who persisted in the development of an improved type of horse through a long period of time.

In general appearance the Shire resembles the Clydesdale, particularly in color markings and the feather of the legs. Pos-

sibly the form of the Shire is more massive and more powerfully built, but it lacks the action of the Clydesdale. The Shire is not as popular in America though a number have been imported from time to time.

Suffolk.—This breed is a native of England and though varying in uniformity, possesses many desirable qualties. Formerly there were several tribes of Suffolks, such as the Blake tribe, Wright tribe, and the Boxer tribe. In more recent years there has been coöperation in the improvement so these strains have merged.

In conformation the Suffolk is somewhat smaller than the other draft breeds, the weight varying from 1600 to 2000 pounds, the height from sixteen hands to seventeen hands. However, the body is characterized by good depth. Chestnut and bay are the characteristic colors. The Suffolk is the least known of the draft breeds in America.

Breeds of ponies.—The breeds of ponies are characterized by their small size, though there is wide variation in both size and conformation. The Shetland pony, a native of the Shetland Islands, is the smallest and in some respects, the most important. In form this pony resembles a small draft horse. The weight varies from two hundred and fifty to five hundred pounds and the height from thirty-two to forty-four inches. All colors are found, but black, brown and spotted are most common. The Shetland is popular in America.

The Welsh pony is a native of Wales. In form this pony resembles the Thoroughbred, but is much smaller, weighing four hundred to seven hundred and fifty pounds and ranging in height from forty-eight to fifty-six inches. This breed is of active temperament and not so popular in America.

Arabian and hackney ponies are similar to the Arabian and hackney breeds already described, with the exception of the size, the weight varying from six hundred to eight hundred pounds and the height under fifty-six inches.

The mule.—This is not a breed, but is a hybrid, the result of a cross between a jack and a mare. In view of the fact that the older countries of the earth have been propagating mules for centuries, it seems strange that it should be left for the United States to prove this animal's economic usefulness. This recognition of the mule's value is very largely due to the intelligence of our southerners who were the first to adapt it to general purposes.

Being a cross between a jack and a mare, the mule differs from

both. Compared with the horse, the head is larger, the ears are longer, the mane and tail are tufted, the body is smaller, the feet are smaller and longer with a greater arch of hoof. The mule is exceedingly variable in size and weight, depending on the parentage. Likewise the color is variable with blacks and browns with light points the more popular. The mule, being a hybrid, is sterile and will not breed.


Fig. 146.—Mule; one of our most economic work animals.

As is often the case with hybrids, the mule is more resistant than either parent. Mules live longer than horses and their period of usefulness is often longer. For long journeys through semi-desert regions, over mountain precipices and through difficult passes, the mule is preferred to the horse. He is unaffected by the climate — cold, hot, moist, dry, it is all in the day's work with the mule. He is found wherever man needs a beast to help bear his burdens, with the pack, under the saddle, and in harness both heavy and light. His docility, his cool-headedness, his resistance to disease, especially those resulting from over-feeding, make him a very desirable animal where ignorant and careless workmen must be relied upon.

BREEDING HORSES ON THE FARM

For about one-half of the year the farmer uses his horses constantly. During the growing season the horses are sometimes overworked, whereas for the remainder of the year the cost of maintaining the animals often exceeds the value of their services. Such is likely to be the case when horses are kept merely for the work that they can do. There are many successful farmers, however, who maintain sufficient horses to do the work of the busy season without overwork. Mares are kept by such farmers, and in order to make them earn their keep during the idle season they are bred, thus producing a colt in addition to the work that they accomplish. Thus, instead of purchasing a team every few years, these farmers derive an income from the sale of surplus stock. The money obtained from the sale of horses that have been raised will fully compensate for the maintenance of all horse stock during the idle season.

The brood mare.—In the selection of breeding stock, the principle of heredity that "like produces like" must not be forgotten. This principle applies to the brood mare as well as to the stallion. Inferior qualities possessed by the mare are as likely to appear in the colt as are inferior qualities possessed by the stallion. The influence of the mare in the transmission of qualities to the foal is often much underestimated, and frequently is ignored entirely by horse-breeders. The general appearance and the pedigree of the stallion are given much prominence, while in the brood mare they are sometimes entirely lost sight of. The farmer who keeps worthless mares for breeding merely because he cannot sell them will not be able to compete with his neighbor who keeps only the best brood mares, even though they both patronize the same stallion.

Selecting the stallion.—In selecting the stallion, there are three important factors to be considered: first, the individual merit, or the perfection of the animal as a representative of its type or breed; secondly, the pedigree, or the purity of the ancestry and the probable capacity of the individual to reproduce itself or to show improvement; and thirdly, the suitability of the two individuals to be mated.

In breeding horses the perfection of the animals selected should be carefully considered. Occasionally stallions are selected on the basis of their pedigree. Such practice may prove disappointing, for many inferior individuals are recorded merely because such animals command a good price on the market. In choosing breeding horses each animal should be closely

inspected, and only superior individuals should be placed in the stud.

Purity of ancestry is an important factor in choosing the stallion, for the capacity of a horse to produce superior offspring will depend largely on his ancestors. Often it is a question which factor should receive a larger share of attention, the individual merit or the pedigree. Formerly great length of pedigree was associated with breeding quality, but the present evidence goes to show that it is the immediate ancestors that are of most importance.

In breeding horses it is a serious but common error to suppose that the bad points in one animal can be fully offset or overcome by the good points in the mate. The popular statement that the stallion controls outward characters and the mare internal characters of the offspring has led many breeders to think that the offspring will resemble the paternal parent irrespective of the mother. Such is not the case. Errors in conformation are not to be offset by choosing a mate that is abnormally developed in the corresponding character. The foundation principle of successful horse-breeding is to mate two animals both of which are as nearly perfect as possible.

Season of the year in which to breed.—Mares breed naturally in early spring. At this season their breeding condition is more readily observed and they more frequently conceive than at any other time during the year. The spring of the year is the natural breeding season; but, because of the heavy spring work, it is necessary on many farms that mares be bred so as to have the colts come in the fall.

Spring foals.—When convenient, the spring is the desirable time to breed the mare. This season has many advantages. Not only is the mare's breeding condition more readily noted and her chances of conceiving greater, but the foal comes at a time when it is much more easily managed. The housing is simplified; if the weather is warm, the mare and the foal may be turned into a small paddock or a pasture. The grass that she eats will serve to keep her in good physical condition and to stimulate the flow of milk. This practice gives the foal the range of the field, so that it may take the much-needed exercise without which no foal can develop endurance. Soon the foal will learn to nibble the grass, and this will prove beneficial, for grass is a good supplement to milk for a suckling colt.

Aside from the inconvenience of the foal while the dam is being worked, the chief objection to a spring colt is that it must

be weaned in the fall just about the time of going on dry feed. At this time the colt must receive extra feed and attention, or it will lose flesh and its future development and usefulness may be retarded.

Fall foals.—On grain farms the heavy work begins in March and continues until August; in dairy districts, where much hay is to be harvested and many silos are to be filled, it may last until October. When fall foals are to be raised the mares should be bred so as to foal as soon as convenient after the season's work, provided the foals do not come when flies are especially annoying. The time of breeding and other details will be modified by circumstances.

While the mare is not so likely to breed in the fall as in the spring — due, in part at least, to her thin condition after the summer's work — yet by increasing the food, especially the grain ration, by blanketing, and by moderate and regular exercise, the desired results can often be attained. The bowels should be kept free from constipation by feeding moderate amounts of succulent food. Conditions should be made as springlike as possible.

If the foal comes in the winter it will need extra warm quarters and extra attention. The dam will need milk-producing foods, such as clover or alfalfa hay, oats, bran, and a few carrots if they are available. She should be exercised regularly. If the breeder feeds succulent food, such as carrots, and provides sufficient exercise for mare and foal, it is possible to raise a winter colt that will be a strong rival to the average spring colt.

Care of the brood mare.—The pregnant mare should receive such a ration as will supply her demands for energy and, in addition, allow ample nourishment for the development of the foal, both before and for a short time after birth. Her work should be so regulated as to protect her from becoming tired, overheated, or injured in any way. There is no secret in raising colts further than feeding to the mother a moderate amount of nutritious food and providing sufficient exercise to keep mare and foal in good physical condition.

Working the pregnant mare.—Moderate work is not only harmless, but positively advantageous, to mares in foal, provided proper care is taken not to overload them. It is much better to work them than to keep them tied in the stable in want of exercise, or to permit them to run at large in fields with other horses where they are exposed to accident resulting from racing, playing, or fighting with each other. Pregnant mares are usu-

ally quarrelsome, and abortions frequently occur from injuries received at the heels of other horses. If proper care be taken, the mare can safely be used at the ordinary work of the farm up to the very day of foaling; but as the time approaches it is important that the work be not heavy or the pace rapid. She must not be fretted by the other horses or by rough, inexperienced hands.

Feeding the pregnant mare.—The food of the pregnant mare is most important. Fat production is to be avoided, and the formation of blood, muscle, and bone should be induced. Foods rich in protein and ash, such as oats, bran, clover, and alfalfa, are preferable to starchy foods, such as corn. A very good ration for the pregnant mare is as follows: four parts ground oats, four parts wheat bran or its equivalent, and one part linseed meal, with bright clover or alfalfa hay for roughage.

Pregnant animals have a tendency to fatten as pregnancy advances. This tendency must be guarded against in the mare, since superfluous flesh may interfere with the development of the foal, cause abortion, or induce difficulties at parturition, such as milk fever and garget. The ration of the mare should be reduced just before foaling and for a short time thereafter, and should be made laxative by the addition of a succulent food, such as carrots, or an occasional bran mash.

The mare after foaling.—If all is normal after foaling, the mare will usually get up and care for her foal. After she is on her feet there should be offered her a drink of gruel, made from a pound of fine oatmeal in half a bucket of water from which the chill has been taken. While the mare should be lightly worked up to the day of foaling, it is essential that she have a few days rest after foaling; how long a rest she should have will depend on the condition of the mare and the foal, and on the financial circumstances of the breeder. As soon as the mare is able, however, she should be given light exercise, since exercise is essential to the well-being of both mare and foal.

The foods given the brood mare when nursing her foal should be such as have a tendency to produce milk. Timothy hay and corn alone are not good milk-producing foods. The ration suggested above for the pregnant mare is better, and it could be much improved if a small quantity of succulent food, such as carrots, were fed with it. Many mares at best are poor milk-producers and they must be encouraged. Plenty of good, fresh grass is one of the best aids to healthy and abundant nutrition for both mare and foal.

The breeder should keep close watch of the mare's udder and the condition of the colt's bowels. If the bowels of the colt are loose and he is scouring, he may be having too much milk. In that case the mare should be partly milked by hand. If the colt is not taking all the milk, it is necessary for the breeder to milk the mare. Otherwise the udder will be greatly distended, will become sore, and may possibly cake, which will result in trouble for both mare and foal.

The young foal.—The young foal that makes its appearance normally and is bright and active needs only to be let alone. If proper attention is given to the food and the exercise of the mare the foal should thrive without special care.

The foal's first meal.—It is essential that the new-born foal receive the first milk from the dam. This foremilk appears thick and yellow, and is a natural purgative for the removal of material that has accumulated in the foal's digestive tract during the last few days of its development. The prompt removal of such material is essential to the life of the colt.

If the foal receives its first meal of colostrum within an hour after birth, it will ordinarily do well. Usually the bowels move within four to six hours.

Feeding the young foal by hand.—It often happens that the milk of the mare is insufficient to promote healthy, vigorous growth in the foal, and occasionally it becomes necessary to raise a foal independently of the dam. In such cases the best addition to, or the best substitute for, the milk of the mare is that of the cow. The milk of the mare contains more sugar and less fat than does the milk of the cow. The breeder should therefore obtain milk from as fresh a cow as possible; the poorer in fat the milk is, the better it will be for the foal, since mare's milk will average only one and one-half per cent fat while the milk of most cows contains more than three per cent.

Patient effort will soon teach the colt to drink milk readily, but care must be taken that it does not receive too much at first. When necessary to feed the new-born foal cow's milk, the milk should be modified. Four tablespoonfuls of limewater should be put into a pint jar, which should then be filled with fresh cow's milk. A dessertspoonful of white granulated sugar should be added for sweetening. The mixture must be warmed to blood heat and the foal should receive half a teacupful every hour at first. As the colt grows older, the amount of food should be increased, and the frequency of feeding should be decreased first to twelve, then to nine, six, and lastly four, times each day.

The purpose is to give the foal all that it will drink, and to feed so often that it will not require a large quantity at a time.

Common disorders of the young foal.—It sometimes happens that the new-born foal cannot breathe. In such a case measures must be taken quickly to establish the function of respiration by blowing violently up the nostrils and into the mouth, and by briskly rubbing the body.

Constipation.—The young foal frequently suffers from constipation of the bowels, especially if the mare has not been in good health during the latter periods of pregnancy. Sometimes the first milk of the dam will not agree with the young foal, or through weakness the foal may not have obtained a good draft. Whatever the cause, if the digestive tract has not been cleaned of its contents within twenty-four hours and if the foal presents a listless appearance, with eyes dull and ears drooping, it is necessary to stimulate action of the bowels. Ordinarily the bowels will be stimulated to action by the administering of two ounces of olive oil or castor oil, and by an injection of warm water into the bowels. The water should be at blood heat and should have added to it a teaspoonful of glycerin and enough warm water to make four or five ounces — but no more, for only a small quantity is needed. This mixture should be injected gently into the rectum with an ordinary two-ounce, hard-rubber syringe. Care must be taken not to rupture the tender membrane. This injection will lubricate the passage and induce the foal to endeavor to pass the fecal matter, which is a yellowish, rather hard, waxy substance. If given as directed, the injection can do no harm and may be repeated every hour.

Diarrhœa.—This disease is rather prevalent among suckling animals and is often fatal. Although less subject to the disease than calves are, foals often die from it within a short period of time after birth. The causes are not certainly known. Ordinarily it is attributed to changes of an unknown character that take place in the composition of the milk.

Rich foods given to the mare may stimulate the flow of milk to such an extent that, if the foal is permitted to take all, digestive disorders and diarrhœa will follow. In early spring when the mare is pasturing on a rank growth of succulent grass, a similar condition is likely to result. For the same reason, a cold, damp bed or exposure to cold rainstorms is to be avoided. While a passing shower, even if cold, may do no harm, prolonged exposure to rain and to a low temperature are likely to prove fatal to a new-born foal. Confinement in close buildings is objection-

able to mare and foal alike; in both it induces a weakened condition and leaves the system an easy prey to disease.

The best practice is to avoid conditions that are likely to cause such disorders. If the dam is properly fed and exercised, there is little danger. On the other hand, should digestive disorders appear, the foal must receive immediate attention and the cause must be removed; even then relief may come too late. When the attack is due to an over-supply of rich milk, the dam should be milked in part by hand.

In administering treatment the nature of the difficulty should not be ignored. It is caused by an irritant in the stomach or the bowels that must be removed before a cure can be effected. In all such cases the best practice is to expel the disturbance with a laxative, such as two ounces of castor oil, and later, after the irritant has been expelled, to check the discharge. Even this treatment is beset by many a difficulty.

Navel infection.—Another disease common to young foals is the so-called navel infection, or joint disease. It should be understood that this disease is due to filth germs that gain access to the body of the foal by way of the open umbilical vein of the navel at birth. When these germs enter the body they set up irritation and inflammation; pus forms and is absorbed into the circulation from the navel abscess, and other abscesses are formed in all parts of the body, especially in the joints of the limbs. The foal is seen to have a swollen joint, and the breeder is likely to think that the mare caused the injury; other joints will soon be affected, however, and the condition may affect the throat and the poll as well. It is comparatively rare that an infected colt can be saved after the disease has reached the pus-forming stage.

It has been proved that simple hygienic measures will prevent the disease. The stall in which the mare foals should have every bit of old bedding, litter, and dirt removed, and the young foal should be born only on clean, fresh bedding. Perhaps it would be a safeguard to wash the stump of the umbilical cord — which should never be cut, but should be allowed to break of its own accord — with a saturated solution of boracic acid, and then to dust it with boracic-acid powder.

Feeding the foal.— As soon as the foal is old enough it should be encouraged to nibble at grain, preferably oatmeal or wheat bran. It will begin to munch grain and hay at three or four weeks of age. If it is necessary that the foal have milk after it is two months old, skimmed milk should be substituted for

the fresh milk of a cow. A colt should never be fed sour milk or milk from unclean vessels. Should there be any trouble from constipation, it will be well to add about one-half pint of oil meal to the ration each day. Oil meal can be fed with profit to growing colts, since it furnishes a large proportion of muscle-forming food. The effect of a ration consisting of sweet skimmed milk, ground oats, and oil meal on the growth and development of a foal is remarkable, and in all cases when the foal is likely to enter winter in low flesh such a ration cannot be too highly recommended.

Most breeders advise leaving the colt in the stable while the mare is at work; others allow the colt to follow the mare into the field. Much depends on the nature of the work that the mare is doing. In some kinds of work the foals may follow without risk to mare or colt, while in other kinds, such as mowing hay or reaping grain, they cannot be allowed to follow. If the foal is kept in the barn, the mare may worry and fret and perhaps heat herself badly at first, but in time she will become accustomed to the separation.

On being brought in from work, the mare should be given a drink, but she should not be allowed to drink too much if she is warm or if the water is very cold. After she has cooled off and some of her milk has been drawn by hand, she may be turned into the stall with the colt with perfect safety to both.

Weaning the foal.—Weaning depends rather on the preparation of the foal for leaving the dam than on the actual removal. The simplicity of the weaning process depends on the thoroughness of the preparation. If the foal has become accustomed to eating grain, if it has been permitted to take increasingly more as it grew, the process of weaning should not be difficult; for as the ration increases in amount of grain, it will decrease in the amount of milk consumed. When the time arrives for complete separation there will be little, if any, inconvenience or disturbance to either foal or dam. On the other hand, if the foal must learn to eat after having been deprived of its accustomed source of supply, it will require time to become adjusted to the new condition, and the mare will demand special care because of the removal of the colt before her milk supply has been gradually diminished.

FEEDING AND CARE OF THE HORSE

The efficiency of the horse and the comfort with which he performs his labor will depend largely on the general care and management that he receives. In some lines of work, neglect one day may largely be made up the next, but in caring for the horse this is not possible. Injury resulting from neglect is always attended with loss that cannot be atoned for, even by special care given subsequently.

The work horse should have rich food; the richer the food, the more easily it is digested and the greater is the proportion that becomes available in energy. He should be fed liberally and frequently. He has a good appetite and a vigorous digestion, and responds to intelligent care. Regularity in feeding, watering, and working brings comfort to the horse and results in long years of usefulness; while irregularity in these essentials is likely to lead to digestive disorders and other derangements.

Amount of food needed.— Many experiments have been conducted in order to determine the relation between the amount of muscular work to be done and the amount of food required for its performance. As a result of such experiments, feeding standards have been established which serve to show the amount of food required each day by a working horse.

This feeding standard should be modified according to the size of the horse as well as the amount and the kind of work that he is required to perform. In practice the work horse is supplied with approximately two and one-half pounds of provender daily for each one hundred pounds weight. Of this amount, one-third to two-thirds — the exact amount depending on the severity of the labor — should be grain, and the remainder should be sweet, clean hay. When work is heavy the grain in the ration should be increased and the hay diminished, since grain furnishes more energy and is more easily digested. On the other hand, when work is light, the grain should be diminished and the hay increased.

While the amount of food to be given a large number of horses can be estimated closely, yet the rations should be modified so as to meet the needs of each animal. One horse may need a little more than the regular allowance and the second horse a little less, since some horses are kept in condition less easily than others doing the same amount of work under similar circumstances.

Order of watering and feeding.— Because of the small size of the horse's stomach, the order of supplying grain, hay, and

water is of much importance. Investigators have shown that the stomach of the horse must be filled and emptied two or three times for each meal given. It appears that during the early stage of the meal the partially digested food is pushed into the intestines by the food that follows soon after it enters the stomach; toward the end of the meal the passage is slow and the digestion in the stomach is more nearly perfect. This being true, it would seem that the more nutritious food should be fed toward the end of the meal, especially since the important nutrients are largely digested in the stomach.

The order in which food should be given cannot be discussed intelligently without considering the time of watering the horse. Many feeders believe that the horse should be watered before feeding, while others are equally certain that feeding should precede watering. The object sought is that the horse shall be fed and watered so frequently that he will feel neither hunger or thirst at any time. He should therefore be fed at least three times, and watered not less than four times — if convenient, six times — each day. He should be watered in the morning before feeding, and for the morning meal should receive approximately one-fourth of the daily allowance at least one hour before going to work. This food should be in a condition to be easily and rapidly consumed, so that it will be well digested when the animal goes to work. As he goes to work he should be watered, and after five hours of exhausting labor he should be given his midday meal, a second quarter of the daily allowance. Before being fed he should again have a drink of fresh, cool water, but care should be taken that he does not drink too rapidly nor gorge himself if he is very warm. If convenient the harness should be removed, so that the horse can eat in comfort and have a few minutes of much-needed rest. One hour should be allowed the horse in which to consume the midday meal. After watering and feeding he is ready for the second half of his day's work. When he has worked for five hours he should be given the evening meal. As he comes to the stable in the evening he should first of all be given a drink; care must be exercised as before to see that he does not drink too rapidly. He is now ready for the remainder of his daily allowance. Thus heavy feeding comes at night, when the horse has ample time to masticate and digest his food and is not obliged to go to work immediately.

Feeds for the work horse.—The ration for horses usually lacks variety. If rations of horses in a given locality are studied, they are found to be composed of one kind, or at most two kinds, of

grain and one forage. The owner insists that this is the most practical and economical ration that he can feed with safety to his horses. In a second locality, at no great distance from the first, the list of food materials is found to be changing, and in some cases entirely changed, yet with the same claim of superiority or necessity as before. Such study convinces us that the range of suitable foods is very wide.

Grains and concentrates.— Most of the grains fed to the horse belong to the cereal group — oats, corn, barley, rye, and wheat. These grains are similar in composition. They contain a fairly low water and protein content and a considerable amount of nitrogen-free extract, fiber, and fat. They are palatable and digestible. The choice of cereal grains for feeding the horse is largely to be determined by relative cost.

Oats.— No other grain is so safe for horse-feeding as old oats, and the animal is rarely harmed if by accident the feeder gives an over-supply. The safety is due to the oat hull, which causes a given weight of grain to possess considerable volume. It is said that horses fed on oats show a spirit that cannot be attained by the use of any other feeding-stuff. Many urge that this is due to a peculiar stimulating substance, called avenin, which the oat is said to possess. Oats may have a flavor that makes them a favorite food; the most careful study, however, has failed to reveal any substance of the nature of avenin. Notwithstanding this, oats have many advantages as a food for horses.

Corn.— Next to oats, corn is the common grain for horses in America. It is used largely in the Corn Belt and to the southward. While much has been said against the use of corn, ordinarily it is the cheapest of all the cereal grains. A given quantity furnishes more energy than does the same quantity of any other food. It furnishes the largest amount of digestible nutrients at the least cost, and is universally palatable. Although corn is not equal to oats as a grain for horses, nevertheless, because of its low cost and its high feeding value, this grain will be used extensively where a large number of horses must be economically maintained.

Corn and oats.— Corn and oats, mixed half and half according to weight, make a very good grain ration for horses and are much cheaper than oats alone. In a three-years test with geldings and brood mares worked on farms and at heavy draft, this mixture gave equally as good results as whole oats and reduced the cost of the ration approximately ten per cent. The bulk of oats overcomes, in large measure, the objectionable features of

corn; while corn, with its large amount of easily digested materials, furnishes the ration with the elements that supply energy.

Barley, rye and wheat.— Each of these grains is sometimes fed to the horse. The question of their use depends largely upon their market price. Usually they are worth more for other purposes. Wheat especially is worth more for milling. Wheat has, however, been fed to the horse with varying success, depending largely on the feeder and the method of feeding it.

Bran.— Because of its physical effect, bran is considered a very valuable addition to the ration of the horse. It has a loosening effect on the bowels and a tendency to allay feverish condition. It is entirely too bulky to constitute any considerable part of the ration of a hard-working animal. It is a very good food for young and growing animals as it is rich in mineral matter and protein, elements that the young animal must have to build up his body. It serves the needs of the grown horse best when given as a "condition" food.

Linseed meal.—This food is very rich in protein and is often fed to the horse in limited quantities, more for the specific effect it has on the horse than for the actual nutrients it contains. It stimulates the skin secretions and gives the horse a very smooth and glossy hair. It can be used as a laxative. Linseed meal is very palatable and easily digestible. It is fattening in its nature and hence desirable if one wishes to fatten his horse. Linseed is valuable as a food for the growing colt because of its high amount of mineral matter and protein. It cannot be fed, however, in very large quantities because of its laxative effect, and some horses cannot eat it at all as it scours them at once.

Molasses.— Numerous trials have been made of feeding molasses to horses, particularly in the South. It is rich in nitrogen-free extract and hence is quite digestible. In the South, where it is fed extensively, it is fed from a large trough and the animals are allowed to eat at will. In the North it is customary to dilute it with water and sprinkle on the hay. Molasses has a good physical effect upon the animal. It encourages skin secretion and keeps the hair fine and glossy. There are some disadvantages connected with the use of molasses, however, as it attracts insects, especially flies and ants, sticks to the animal's coat, halter, tie strap and manger, and is difficult to mix with other foods.

Patent stock foods.— If the horse is slightly out of order, or if the food is not as good as it should be, the use of condimental or patent stock foods may be of advantage in bringing the ani-

mal up to the normal condition. The price at which these patent foods are sold makes them extremely expensive to the consumer, and the profits that accrue from their sale are great. Yet if one has a horse that is out of condition it may be profitable to buy a package of this food.

Hay and forage.—The kinds of forage or hay that are available for horse-feeding are as numerous as the grains, and vary about as widely in their composition. Forage on the average contains only about one-half of the energy value of grain. It differs from grain in that it contains more water and more crude fiber.

Timothy hay.—Although not particularly rich in digestible nutrients timothy is the standard hay for horse-feeding. There are many reasons for its popularity: It can be grown successfully in nearly all localities and is the principal market hay; it is difficult to adulterate with other grasses or weeds without detection; it is relished by horses; it is free from dust, all of which conditions commend good timothy hay as a horse food.

Clover.—This hay has not been held in high esteem as a forage for horses. The reasons are obvious. It is generally loaded with dust, and this is often hard to prevent. This can be overcome in large measure by moistening the hay before feeding. When bright and clean it is a very valuable food for the horse, especially for the young and growing colt, as it is rich in protein and mineral matter; in fact, it makes a better ration than timothy when fed in limited quantities.

Alfalfa hay.—This hay belongs to the same natural family as clover hay and meets with similar objections. It is likely to be dusty, especially when grown in regions of considerable rainfall. It seems certain that alfalfa fed in limited quantities will prove as efficient as timothy to the slow-going draft horse. Horses are very fond of alfalfa, and it is necessary to guard against feeding an over-supply. Like clover, there is no better forage for the young and growing colt.

Corn stalks.—Dry corn stalks that have been cured in the shock are sometimes fed as a substitute for hay. Experiments and experience have shown that in the fall before the leaves are leached it is as valuable as timothy hay, pound for pound consumed. The stalks cost only one-third as much as the timothy and therefore they prove much more economical.

Straw.—The straw of the various cereal grains is sometimes fed to the horse as part of his roughage. While the straw has some value, the horse requires much more grain when hay is

replaced by straw. Idle work horses in winter can utilize some straw, but they should not be compelled to subsist wholly on it as it contains much fibrous material and is largely indigestible. It should never be fed to hard-working animals. In relative value for horse-feeding, the straws rank in the following order: Oats, barley, wheat and rye, the latter being of little use as a horse food.

Silage.—This succulent food has been fed to the horse from time to time with varying success. If the silage is good and is fed in moderate quantities, it may be given to idle horses, to idle brood mares and to growing colts with safety. It should not be fed to the hard-working animal, as he must consume too much to get sufficient nutrients to avail him much energy because of the high percentage of water.

Roots and tubers.— Carrots, rutabagas, potatoes and other roots and tubers are occasionally fed to the horse. These foods contain a high percentage of water and small amounts of nutrients. The use of such materials for horses has been attempted at different times with varying successes, but they are not used to any great extent in this country, although quite common in Europe. Carrots are often fed as "conditioners." For that purpose their value is high, but for actual nutrition it is very low.

Cost of the ration.—In formulating the ration for the work horse due consideration should be given the cost, which will vary with the size of the animal and the nature of the work to be performed as well as with the cost of feed. Hays are ordinarily much cheaper than grains, especially on farms. The hard-working horse, however, is unable to dispose economically of a large proportion of bulky food, since time and energy are required for mastication and digestion of rough food.

In the choice of grains, their cost is given little or no consideration by the average person. Thus oats are fed, although they constitute the most expensive grain on the market and equally good results would be obtained by feeding some cheaper grain, in part at least.

Every feeder should make a careful study of the foods available and choose those that best meet the conditions.

Feeding the idle horse.—On the farm, most of the work comes during the growing season. It is more economical and is perhaps advisable that the idle horse be turned into a lot — if the lot is well protected — and roughed through the winter, rather than confined too closely in a barn. As winter comes on, the

horse will grow a heavy coat of hair, which will afford excellent protection. Such horses may be maintained largely on hay, straw, or corn fodder, fed uncut, since they have time to masticate their food and are able to subsist on food containing a large percentge of crude fiber. However, if straw or corn fodder is used, some grain should be fed in addition, say four to six pounds a day. It is considered better to have the digestive system of the idle horse moderately distended with coarse material than to have the system contracted, as would be the case if grains composed of only the requisite nutrients were supplied. If the protected area in the field is kept dry and well bedded, the horse can be comfortably wintered in this way at much less expense than by stabling. In order to put the horse in condition, light work and feeding with grain should begin six weeks before the spring work starts.

Salting the horse.—Salt in limited quantities should be kept before the horse at all times. It is not good practice to place too much salt before him at one time, for some horses will eat to excess. Abnormal thirst is likely to follow too plentiful salting, and if sufficient water is given to relieve the thirst digestive disorders may result. Salt should not be placed in the food, since this practice often causes derangement of the digestive organs.

Grooming.— The grooming of the horse deserves careful consideration. Nothing else contributes so largely as efficient grooming to the beauty and luster of his coat. Because of this, the body usually receives sufficient attention but the legs receive entirely too little. If the animal's legs are muddy when he arrives at the stable, they should be roughly cleaned with a half-worn, common broom; the animal should be placed in the stall, fed, unharnessed, groomed thoroughly, and blanketed. The legs should then be given a thorough, rapid brushing. Time spent in cleaning and rubbing the horse in the evening, after the day's work is done, is of much greater benefit to the animal than the same amount of time thus spent in the morning.

If the animal is working in mud it is desirable that the hair be clipped from his legs; if this is done, the legs may be kept clean with much less difficulty than if the hair is not clipped. In case the legs are clipped, it is all the more important that they should be thoroughly cleaned and rubbed each evening after work. The hoofs should be examined and the cleft between the sole and the frog should be cleaned. Animals cared for in this manner will pay for the extra care many times over by

coming from the stable in the morning in the best of spirit. This will be indicated by their pleasing appearance, the snap and vigor with which they lift their feet, and the complete absence of stiffness in their joints. Animals whose limbs are thus cared for will remain comparatively free from the many diseases to which the legs and the feet are subject. Such care will greatly increase the efficiency of the horse and will prolong his usefulness.

Clipping.—This consists of cutting the hair over the entire surface of the body of the horse. Several advantages are claimed for clipping: it improves the appearance of the horse and enables his coat to be more easily cleaned; a clipped horse is less likely to take cold than a long-haired horse because the evaporation of moisture is more rapid and the horse does not become so warm; the natural process of shedding hair is a draft on the vitality of the animal, leading to a diminished appetite and to loss of flesh. Clipping accomplishes in a short time what nature requires much more time to do. From this it would seem that horses having long, thick coats should be clipped.

If horses are to be clipped twice each year the first clipping should be done soon after the hair has grown out in the fall; thus the horses become used to the change before cold weather and obtain some growth of hair before winter sets in. The second clipping should be done in early spring as soon as the weather begins to grow warm and before the animals begin to shed their winter coats. Horses thus treated will be much more easily kept in presentable condition and, if protected by blankets and properly groomed, will pay many times over for such extra care. When horses cannot be protected from cold and wet, either in the stable or outside of it, they should not be clipped in the fall. Animals exposed to the weather grow a long coat for their own protection and this should not be removed; if, however, the owner means to give them extra care and attention, they may be clipped.

Blanketing.—In our climate the use of a blanket is indispensable. A horse will be more efficient and will endure much longer if reasonably protected against cold rains, heavy winds, and sudden changes in temperature. If the horse is warm and sweating on his arrival at the stable he should not be blanketed until he has ceased to steam, nor should he be left in a draft. If blanketed at once there is little opportunity for the horse to dry, the blanket becomes damp, and the hair of the horse remains moist all night. In case the blanket is not used until the animal has

ceased to steam and is somewhat cool — which will be in a quarter of an hour — the hair will be dry and smooth on the following morning.

Some caretakers of horses use two stable blankets. One is placed on the animal immediately after he arrives in the stable; this is removed in a quarter of an hour, being replaced by another that is to remain on the animal during the night. This is perhaps advisable in very cold climates, since the animal may cool off too quickly if not given some protection on arriving at the stable.

The stable blankets may be dispensed with in hot summer months if flies are excluded by screens or some other means. If blankets are used at this time they should be of light material and should be kept clean. As soon as the nights begin to be cool the use of blankets should be resumed; early use will markedly arrest the growth of hair and occasionally will obviate the necessity of clipping.

The use of the outdoor blanket is as important as that of the stable blanket. If the horse is allowed to stand outdoors for either a short or a long time he should be well blanketed. In very cold weather the blanket should be secured about the abdomen by blanket pins.

The proper use of fly blankets or fly nets brings much comfort to the horse. Whether it is better to use nets or blankets will depend on circumstances. The blanket, being warmer and less presentable, is not advised by many persons; there are conditions, however, under which it appears very desirable, particularly on horses whose color fades on being exposed to the direct rays of the sun. Nets are more presentable and therefore are more approved by horsemen generally. Both nets and blankets are annoying to the driver, warm for the animal, and more or less expensive. For these reasons they are often discarded entirely, although their judicious use is often of advantage to horses.

Bedding.—Bedding should always be used liberally. A horse at hard work needs rest at night, and much more rest is to be obtained if the horse is given a good bed. The bedding should not be permitted to become foul; foul bedding not only will lessen the comfort of the animal, but also will promote disease. Of bedding materials, straw proves the most satisfactory; when high in price it may be replaced by other materials, such as shavings from the planing mill, rejected pieces of cornstalks, tanbark, or leaves. Old straw is preferable to new, being drier

and more elastic. The more broken and bruised the straw is, the less bulk and elasticity it has; hence a greater quantity is needed.

Care of the teeth.—Occasionally a horse is found that does not feed well owing to irregular growth of his teeth. If the first, or milk, teeth are not looked after, they are likely to remain, causing the second, or permanent, teeth to grow in crooked. The mouth of a young horse should be watched closely and the persistent milk teeth should be removed with forceps. It must be remembered also that the upper jaw is somewhat wider than the lower, and, from the fact that the teeth are not exactly opposite, a sharp edge is left unworn on the inside of the lower molars and on the outside of the upper, which may cut the tongue and the cheeks. If this condition exists the edge can readily be felt by the hand, and such sharp edges, when found, should be rasped down by a guarded rasp; otherwise the tongue and the cheeks become sore food irritates them, and the horse will not feed well.

When a horse quids his food, when he drivels, or when he evinces pain in mastication as shown by holding the head to one side while chewing, the teeth should be carefully examined. In addition to not feeding well, a horse whose teeth have unduly sharp edges is likely to drive badly, to pull to one side, not to bear on the bit or to bear on too hard, to toss the head, and to start suddenly when a tender spot is touched.

Care of the feet.—Because of the great importance of the feet they should be carefully watched throughout the active career of the horse. Each evening after returning from work, as well as in the morning before being sent out, the sole of the foot should be examined and all foreign materials should be removed. For this purpose a small hay hook, with the point sharpened, is excellent. Frequently foreign bodies, such as nails or stones, either are driven into the sole of the foot or collect in the cleft along the frog, and it is very essential that these be removed if the hoof is to remain in a healthy condition. Occasionally a hoof has a tendency to dry out and thus become hard and brittle. Such a hoof should be oiled with good oil or hoof ointment. This will soften the sole and make it less likely to crack or break. Again, it often happens that a piece is worn or broken from the side of the hoof; this throws the weight of the body in such a manner as to bring a strain on the joints, which may cause deformity. When such breaks occur the hoof should be leveled with a rasp. When horses are too closely confined in the stable

the hoof grows out long and, if not trimmed, will often deform the limb and make traveling difficult. It is important, therefore, that such a foot receive proper attention.

The rate of growth of the hoof is of much importance, for it enables the owner to know how long it will take a crack — such as a quarter crack, side crack, toe crack, cleft, or calk — to disappear. When the rate of growth of the hoof is known approximately, the length of time required for such an injury to grow out is easily estimated. On the average, the hoof grows a third of an inch in a month. Hind hoofs grow faster than front hoofs, and unshod hoofs grow faster than those that are shod. While influenced to some extent by work, exercise, climate, moisture, and food, the time required for the horn to grow from the coronet to the ground varies in proportion to the distance of the coronet from the ground. The toe, therefore, grows down in ten to thirteen months (depending on its height), the side in six to eight months, and the heel in three to five months.

Adjustment of the harness.— Since the horse receives commands and accomplishes his work by means of the harness, a perfectly adjusted harness adds much to his comfort and increases his usefulness. Unequal pressure due to poorly fitting harness is likely to abrade the flesh and leave an impression with the horse that he is being punished, which may cause him to develop vicious habits. This is illustrated by the fact that a sore mouth produced by a poorly fitted bridle or bit may induce the horse to run away; often a sore neck or shoulder resulting from an ill-fitting collar makes a horse balk; and often a sore tail produced by an improperly adjusted crupper causes a horse to kick. Since not only the usefulness of the horse, but his safety as well, depends largely on the adjustment of the harness, much careful consideration should be given to this matter.

Fitting collar.— Since the service of the horse is largely accomplished by means of the collar, it is of the utmost importance that this fit the neck and shoulder perfectly; and since the shoulders of no two horses are exactly alike, each should have his own collar. Unequal pressure due to a poorly fitting collar causes the horse much pain and often results in a sore neck or sore shoulders. In order to avoid such sores, the collar should be properly adjusted. Leather collars are so firm and stiff that it is often difficult to adjust them to the neck and shoulders. In order to overcome this difficulty the poorly fitting collar, whether new or old, should be wrapped round and round with thoroughly wet sacking and allowed to remain so wrapped overnight. In

the morning the soaked collar should be adjusted snugly to the horse's neck with the hame straps. Then the horse should be worked moderately through the day. Soaking the collar in this way serves to soften it, after which it will adjust itself to every inequality of the shoulders and the horse will seldom be troubled with soreness.

Sore shoulder.—In case such sores occur, the parts may be washed with cold salt water and, when dry, dusted with tannin or finely pulverized, air-slaked lime. Oxide of zinc ointment is good. This is made by mixing one ounce of oxide of zinc with four ounces of benzoated lard. If the parts become calloused a dull red blister may be applied, which will absorb the callous. It will be necessary to rest the horse while applying the blister.

Care of the harness.—The harness should receive good care, as this will increase the duration of its usefulness and lessen the likelihood of its injuring the horse. It is very important that the bearing parts be kept scrupulously clean at all times. This applies especially to collar, saddle, and crupper. It is not possible to prevent sores if these parts are permitted to become dirty, which they are sure to do, if not cared for, because of sweat and dandruff. Collar, saddle, and crupper should be thoroughly cleaned each morning before the horse is harnessed.

Training and breaking the colt.—The profit and pleasure to be derived from the use of a horse depend on his being subservient to his master's will. The more complete his training the better horse he will be. The problem is, then, so to train the horse as to bring him to his maximum usefulness. This is difficult. No rules can be laid down that will apply in their entirety, or in every case. Much depends on attendant conditions. The type or breed, the individuality of the horse, the individuality of the trainer, the object for which the horse is being trained, are factors that will have much influence on the methods of training. No attempt is made here to discuss the various training methods, or to go into the matter in detail; only a few brief suggestions are given in the hope that they will clarify the mysteries of so-called "horse breaking," for entirely too much is ordinarily made of training the horse, particularly the heavy types.

The colt should become familiar with man while young. In the very beginning he should be taught subordination and should not be allowed to become willful or headstrong. The usefulness of the horse will depend much on his courage and fearlessness, and it is in order to promote these characteristics that the colt

should become familiar with man at as early an age as possible. If taken in time and properly handled, he need never know fear. A colt should never be frightened. Too many persons thoughtlessly try to tease the young colt by running at it or throwing

FIG. 147.—Method of catching young foal.

sticks at it — practices which should never be indulged if a reliable animal is to be developed. The colt should be taught useful lessons only. Because colts are bright and susceptible to training, they are often taught tricks and allowed to become mischievous. A colt that bites, rears, or kicks may seem amusing at first, but this very behavior may later prove an annoyance that is difficult to overcome. The trainer should not make the

mistake of trying to teach the colt too much at a time; he should be sure that it understands each lesson thoroughly before another is attempted. On the other hand, colts should be trained continuously day by day, and not merely at the convenience of the trainer. The trainer should be gentle and firm at all times and should accomplish whatever he attempts to accomplish.

Teaching the foal to lead.—The colt should be caught by putting one hand under the neck and the other under the hams or around the buttocks; he should never be caught around the neck alone, for if this is done he will go backward and perhaps fall. If he attempts to go forward, press back with the hand under his neck; and if he attempts to go backward, press forward with the hand around the buttocks. Colts caught in this way will allow persons to walk up to them, whereas if they are caught around the neck there may be difficulty in catching them.

When the foal is to be haltered, a strong, well-fitting halter should be chosen; it should not be a new one that smells strangely to the colt, but one that has recently been used. Care should be taken not to pull heavily on the nose-band at any time; occasionally deformed face lines and imperfect necks are caused by this means. It is not necessary to drag a colt by the halter in order to suggest to him that his business is to follow. After such treatment, the reverse effect is usual; the harder the colt is pulled, the harder he pulls back. If, on the contrary, he is coaxed along the accustomed route, for example to the watering trough and back, he will soon follow promptly.

If he continues to resist, however, other means must be tried. At all events the trainer should not stand in front of the colt and try to pull his head forward, for he will roll his eyes, shake his head, and step back. Advantage must be taken of the colt's natural tendency to step forward when pressure is brought to bear on the buttocks. A small rope, the size of a sash cord and about ten feet long, with a noose or a ring at one end, should be placed gently over the colt's back just in front of the hips, with the noose or the ring on the underside of the body. When the other end of the rope is run through the noose, the rope can be closely drawn around the flanks, passed along under the body between the forelegs, and then up through the ring in the halter. This is called the loin hitch. The trainer should pull gently on the halter strap with one hand, and, as the colt begins to shake his head, give the light rope a sharp pull with the other hand; the colt will immediately step forward. If the colt is given time to become used to the lesson, he will soon follow wherever he is

led. Some trainers prefer the quarters hitch rather than the loin hitch.

Training to the uses of the bit.— It is perhaps best to train the horse to the uses of the bit when he is about two years of age. The manner in which the horse is educated to the uses of the bit will go far toward determining his usefulness. Inasmuch as the master's desire is conveyed to the mind of the horse through the medium of hands, reins, bit, and mouth, no progress can be made, and none should be attempted, until this means of communication has been established.

Importance of a good mouth.— No other factor contributes so

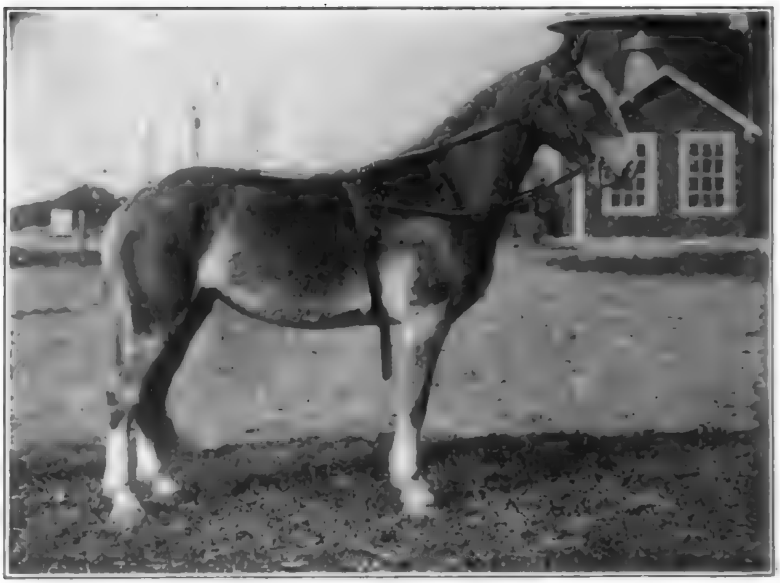

FIG. 148.—Bitting harness for teaching uses of the bit.

much to the pleasure, comfort, and safety of the driver of a horse as a responsive mouth that promptly obeys the slightest instruction from the master. In general a good mouth is natural to the horse. A bad mouth usually results from improper handling, and often is the cause of many other imperfections, such as a tongue lolling, crossing the jaws, hobbling, and irregular and unsteady gaits, many of which, when well established, are difficult to overcome.

Bitting the colt.— The young animal can usually be made familiar with the uses of the bit by the application of the bitting harness, or dumb jockey as it is sometimes called. This bitting harness consists of an open bridle, with large, smooth bit, a

checkrein, surcingle and crupper, and two side lines running from the bit to buckles on either side of the surcingle. The adjustment of the bridle is important. The length of the headstall must be so adjusted as to bring the bit in mild contact with the bars of the mouth. If the headstall is too short, the bars and the corners of the mouth soon become sore and the animal may become vicious; on the other hand, if it is too long, the bit drops down in the mouth and the animal becomes careless. With the bitting harness properly adjusted, the colt may be turned into the familiar open paddock in order to become accustomed to having the bit in his mouth. The checkrein and the side reins should be left slack at first. Gradually from day to day the reins should be shortened, although care must be taken that they are never made so short as to place the head in an uncomfortable position, or to tighten the bit and make the corners of the mouth sore. During a few hours each day for perhaps a week or less, the colt should be subjected to the use of this apparatus. The side reins may now be substituted for real lines, and the colt may be driven until he knows how to guide this way and that, to stop at the word "whoa," and to step forward at the command "get up." He should be trained to stand absolutely still when he is being harnessed or saddled, or at any time when it is desired that he should do so. A horse that is continually stepping about while being harnessed is but half trained. The trainer should be gentle at all times, but he should accomplish everything that is undertaken.

Harnessing the colt.—After the colt has become familiar with the bitting apparatus and has learned to obey simple commands, he may be harnessed.

Before being harnessed or hitched, the colt should be made familiar with the pressure caused by the harness and the shafts. In order to do this, a light pole, eight to ten feet long, should be held for the colt to smell and to touch with his nose. The pole should be rubbed gently over the nose, the side of the face, and up to the mane and crest. After scratching the crest the pole should be brought back to the withers, down over the shoulders, and along the outside and inside of the forelegs. The pole should then pass along the back to the hind quarters, and down along the outside and the inside of the hind legs. The process should be repeated first on one side and then on the other, and every part of the body should be touched, until the colt becomes perfectly submissive.

The harness should be of good quality and in good repair, and

should fit perfectly; if a part breaks, the colt may be ruined for all time. The collar should receive especial attention, since it is through this agency that the horse exerts his power, and the colt's shoulders are likely to be tender and easily abraded. The collar must be kept scrupulously clean. If the colt loses flesh, the collar which fitted perfectly in the beginning may become too large. A breast collar is admissible when the load is light. It

Fig. 149.—Hitched for the first time, showing kick strap over rump, and safety ropes to prevent running and the like.

must not be adjusted so high as to choke the animal, nor should it be so low as to interfere with the action of his limbs. The saddle and the crupper also need careful attention. Care should be taken to have them fit and to keep them clean, lest they abrade the back or the tail and render a horse vicious.

Hitching single.—When the colt is desired for single use, it is often advisable to train him to go single from the first. This may be done after he has become familiar with the bit, the harness, and the use of the lines. When training the colt to go single, a training cart, substantially constructed with long shafts and with a seat so arranged that the driver can mount and dismount quickly, should be employed. Such a cart can easily be constructed from the rear wheels and the axle of a buggy or a

carriage by fastening two long poles (of hickory or any tough, springy wood) to the axle, a crossbar and a whiffletree in front, and a board seat in the rear. The shafts should be twelve or fourteen feet long, with provision at the ends for the attachment of a strap across from point to point in order to prevent the colt in rearing from throwing his front leg over the end of the shaft. At first a kicking strap attached to each shaft and passed over the colt's rump should be used, at least until the colt is accustomed to the shafts. When the colt is first hitched, an assistant should hold him until the driver is ready, and then he should be allowed to go. As soon as he has become familiar with the vehicle, he should be taught to stand still until he is told to go.

Hitching double.—With the harness properly adjusted the colt is ready to be hitched to a vehicle. Get a well-trained, gentle, but active horse if the colt is active, for it is a mistake to hitch a quick, active colt with a slow, lazy horse. The vehicle to which they are attached should be provided with a good brake. The colt should be attached to the "off side" and they should be driven at first in a closed field till the colt learns what is wanted of him. When hitching the colt double for the first few times, it is well to keep a pair of single lines on the colt's bridle which can be handled by an assistant.

Training the colt to walk fast.— There is no gait more valuable, more appreciated, and more practically useful in a horse than a fast, square walk. It is not difficult to train the average colt to walk fast, provided the proper methods are employed in early training. From the very beginning the colt should be walked as swiftly as he is able to walk, in order that he may form the habit of fast walking. He should never be allowed to mope along, or the habit will become strongly fixed.

Training vicious horses.—In training or handling vicious horses, it is important to impress them firmly with the idea that the trainer has complete control over them and that they must obey. There are several ways of conveying this idea. Perhaps the most effective means is to contrive a self-punishing harness. With such a harness the vicious horse deals out his own punishment at the instant he violates his trainer's wish. While many appliances have been devised for the control of vicious horses, perhaps that invented by Mr. Rarey and used in his so-called "Rarey system" is as effective as any. This harness consists of two short straps fitted with D-shaped rings, a surcingle, and a long rope. The straps are buckled around the front pasterns and

the surcingle around the body. One end of the rope is tied into the ring in the strap that goes around the pastern of the left, or near, front foot. The free end is then passed through a ring on the underside of the surcingle and down through the ring at the other pastern. Then the rope end is brought up and passed through a ring, tied about halfway down the right, or off side of the surcingle. If the animal becomes unruly it is necessary only to pull on the rope, which brings his front foot up to his chest, and the animal comes down on his knees and his nose. A few hard falls will usually teach the most incorrigible, but such a dangerous practice should be followed only as a last resort and after all other means have failed. It sometimes happens that horses permanently injure their knees or even break their necks as a result of a fall.

By the application of such methods, the most vicious animals can ordinarily be brought under control. If the horse with a disposition to kick, rear, bolt, buck, or run can be persuaded that he is merely punishing himself, he will soon understand that he must not indulge in such practices. It should be remembered, however, that such animals are not trustworthy and should never be left to the care of persons incompetent to meet an emergency.

DISEASES OF THE HORSE

By J. H. Hewitt, D.V.M.[1]

Overloading the stomach is generally caused by the horse getting into the feed but may be caused in other ways. The horse is at first dull, hanging back on the halter, later pain may begin increasing in severity. Early before symptoms begin give stimulants such as F. E. nux vomica one teaspoonful, repeated in four hours, or one ounce each of sweet spirits nitre and aromatic spirits ammonia, repeated in one-half hour. If pain continues call a veterinarian.

Cramp colic is generally brought on by chilling, either from exposure or drinking an excess of cold water when warm. It may be caused by spoiled foods or improper feeding. The animal is attacked suddenly and the pains come in intermittent attacks. Give quieting medicine such as two ounces of laudanum in water or one ounce chloral hydrate in one pint water or two ounces sweet spirits nitre and one tablespoonful ginger in water.

Wind colic is caused by a change in feeds or poor feeds and improper feeding. The animal is bloated, showing more on the

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right side. Pain is of a continuous nature. Give a purgative such as one quart of raw linseed oil or one ounce of aloes or tablespoonful of ginger; also give rectal injections of one-half pail soapy water.

Bots.— The larval stage of the bot fly, cannot be removed by medicine without injury to the horse. They pass out normally in the spring and summer to develop into flies. Prevent by rubbing with cloth saturated with kerosene over eggs on hair of legs and side.

Stomach worms.— Large and long, causing an unthrifty condition, depraved appetite, sometimes colic. Give one teaspoonful daily for one week of a mixture of equal parts of copper sulphate and iron sulphate or one ounce turpentine in a little raw linseed oil on an empty stomach for two or three mornings.

Pin worms are located in rectum. Give rectal injections every other day of four quarts of warm water in which one ounce of iron sulphate has been dissolved.

Constipation.— For mature horses give one quart raw linseed oil or one ounce aloes. For mature cows two pounds Epsom salts and tablespoonful ginger or one quart raw linseed oil. For calves two to four ounces castor oil. For colts two to four ounces castor oil; sheep one-quarter pound Epsom salts; lambs one-half to one tablespoonful castor oil; large pigs four ounces castor oil. The salts and oil can be repeated in twenty-four hours, the aloes in thirty-six.

Diarrhœa.—Opposite of constipation. Is caused by a sudden change of feed, spoiled or musty feed, infection. For mature horses and cows give one pint castor oil and two ounces laudanum followed with tablespoonful of iron sulphate three times daily. For calves, colts, sheep, and swine give two to four ounces castor oil and one tablespoonful laudanum followed by one teaspoonful iron sulphate.

Chill.— Caused from exposure, infection or the starting of a contagious disease; provide plenty of blankets and make animal comfortable, give internally thirty drops tincture of aconite and one teaspoonful F. E. belladonna. Repeat in one hour, if necessary, or give one tablespoonful of ginger or one ounce tr. arnica. If chill continues call veterinarian. Many diseases are ushered in by a chill and by breaking it up early the severity of the attack will be lessened.

Fever.— Is not a disease but a symptom of a disease in which there is a disturbance in the heat of the body, with cold extremities, as ears and legs. A chill often ends with a fever. Make

the animal comfortable and apply blankets; give internally one tablespoonful every six hours of the following:

Tincture of aconite	one ounce
F. E. belladonna	two ounces
Saltpeter	four ounces
Ammonium chloride	four ounces
Water to make	one pint

Cold in the head.— Caused by exposure, draughts, damp stables, poor ventilation; there is a nasal discharge and sometimes a cough. Put horse in dry, well-ventilated quarters, feed laxative food and give one teaspoonful of sulphate of iron three times daily.

Cough.— When accompanied by a disease such as distemper should be treated with that disease. When the animal seems to be well otherwise give one tablespoonful of the following mixture three times daily:

F. E. belladonna	one ounce
F. E. stramonium	one ounce
F. E. lobelia	one ounce
Molasses sufficient to make	one pint

Bronchitis.— Is an inflammation of the windpipe branching to each lung. Caused by infection, exposure and draughts. There is a painful cough, a high fever, and generally dullness and loss of appetite. Do not work the horse, as pneumonia may develop. Give animal dry, well-ventilated quarters, plenty of blankets and the treatment for three or four days given under fever. If animal is no better call veterinarian.

Pneumonia.— Is an inflammation of the lungs caused same as bronchitis. Animal is dull, has high fever, and very rapid breathing. Do not work and in addition to the treatment given under bronchitis apply a mustard paste over the ribs. Take one tablespoonful of mustard and two of flour and mix into a thick paste with warm water, rub well into the hair and cover with paper, change in twenty-four hours. If the horse is no better call veterinarian.

Heaves.— Heaves generally develop in horses that are fed large amounts of hay, especially if such is dusty or mouldy. Frequently it follows distemper. There is generally a cough with the heaves, and sometimes a rattling in the throat. Feed the horse succulent food as much as possible and avoid much hay. Feed grass, cornstalks, ensilage; begin light, so as not to cause colic; also give medicine recommended for cough, or Fow-

ler's solution, one teaspoonful three times daily in feed for a mature horse.

Stocking of the legs.— Give horses regular exercise, good food, succulent, if possible; one quart of raw linseed oil followed by one teaspoonful of saltpeter, in feed three times daily for one week, skip a week, then repeat.

Nail in the foot.— Cut down to sensitive structures, inject tincture of iodine. If horse continues in lameness have blacksmith or veterinarian enlarge opening to let out pus, then keep clean and inject tincture of iodine daily.

CHAPTER XV

DAIRY CATTLE

By Prof. John McNutt, B.S.[1]

The dairy cow occupies a very important place in American agriculture to-day. Her ability to convert coarse feed into palatable, nutritious human food, more efficiently, than any other animal places her in the first rank among the domestic animals. Fortunately, the dairy industry received an early start in this country and it has grown steadily until at the present time it is one of the most important lines of our agricultural industry. Originally the industry was largely centered in the eastern states; but with the development of the farming lands of the middle west, south and far west the industry has spread all over our country. Fine dairy herds are being kept at present where it would have been thought impossible to interest people in dairying fifty years ago. The opportunities for development of the industry, in the south and west, are almost unlimited; and no doubt the greatest growth will occur in those sections in the future. In the more thickly populated sections the product is handled and consumed as fresh milk; whereas, in the remote sections butter and cheese are made. These can be shipped great distances to market. The possibilities of marketing dairy products makes the industry adaptable to a variety of conditions.

Breeds of dairy cattle.— The four leading breeds of dairy cattle, found in the United States, are the Jersey, Guernsey, Ayrshire, and Holstein. In addition there are a few Dutch Belted, French Canadian, and Kerry Cattle. It is also necessary to mention some of the Dual-purpose breeds because of their value and importance in milk production. The most important are the Milking Short-horn, Brown Swiss, Red Polled, and Devon.

The Jersey breed.— The Jersey breed had its origin on the Island of Jersey. This island is one of the group known as the Channel Islands in the British Channel off the coast of France. Other islands in the group are Guernsey, Alderney, and Sark. Jersey is the largest of the group and it contains about 40,000

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acres. The climate is mild and market gardening is the chief industry. The farms are small and the farming is done on an intensive scale.

Origin of the Jersey.—While definite historical records are not available it is thought that the Jersey breed originated from foundation animals brought from the mainland of France. The cattle of Brittany and Normandy resemble the Jersey in many

FIG. 150.—Jersey bull. Leda's Raleigh. Grand champion National Dairy Show 1919.

respects. The purity of the Jersey breed has been guarded in its native land. In 1763 laws were passed preventing the importation of any cattle to the island except for slaughter within twenty-four hours.

In size the Jersey is the smallest of the four leading dairy breeds. Mature bulls usually weighing from twelve hundred to fifteen hundred pounds and mature cows from eight hundred to eleven hundred pounds. The breed matures early. The heifers usually breeding earlier than the other dairy breeds. However, the best age for them to freshen the first time is from twenty-two to twenty-six months of age, if they are well grown.

In color the breed shows considerable variation from very light silver fawn to deep mulberry brown. White markings may occur without indicating impurity of breeding.

The ability of the breed to become adapted to a wide variety of conditions is remarkable. They can be found in England, France, Australia, Canada and all over the United States. The Jersey is more thoroughly distributed over the United States than any other dairy breed.

Importations first came to this country early in the nineteenth century but not until the latter part of the century were cattle

Fig. 151.—Jersey cow. Oxford Majesty Gypsy. Grand champion National Dairy Show 1917–1918.

brought here in great numbers. During the last thirty years many excellent cattle have been imported and the breed has multiplied rapidly so that at the present time the Jersey doubtless excels the other dairy breeds in numbers in the United States.

The breed is noted the world over for its efficient butter production. Many excellent milk and butter records are being made by cows on yearly test which is helping the breed to gain favor. The ability of the cows to make good records under practical farm conditions and produce so economically is a strong point in their favor.

Prominent and popular Jersey families of to-day are the "Oxford Lads, Majesties, Raleighs, Sophie Tormentor, Gamboge, Combination, and Owl-Interest." The interests of the

breed are looked after by the American Jersey Cattle Club, offices at 324 West 23d Street, New York City. The last volume of the herd book published in 1919 indicates the registration of 167,500 bulls, 430,000 cows.

The Guernsey breed.— The Guernsey had its origin on the island of the same name in the British Channel. The climatic

FIG. 152.—Guernsey bull. Langwater College King. An excellent breeding and show bull.

and food conditions are very similar to that of Jersey only a short distance away. Market gardening is the chief industry on the island as is the case on Jersey. The island is smaller than Jersey, containing only about 12,500 acres. Fruit and vegetables are grown under glass for shipment to English markets. The farms are small and the cattle are kept in small herds under rather close confinement.

The origin of the Guernsey is thought to be about the same as that of the Jersey. The breed shows somewhat more resemblance to French breeds than does the Jersey.

Breed characteristics.— In size the mature bulls will average from thirteen hundred to sixteen hundred. The cows from nine hundred to twelve hundred pounds.

In color the breed is usually a reddish-fawn, broken irregularly

with white markings. However, solid colored animals do occur. Rich creamy skin secretion is considered a valuable point in selection, as it is thought to indicate richness of milk.

The breed is noted for its production of rich yellow milk. The cows are larger than Jerseys and will average a little more milk production. The richness of the milk will average about the same as the Jersey, and the yellow color is more evident. The breed does not mature quite as early as the Jersey and the

FIG. 153.—Guernsey cow. Langwater Hope. Record 10.882 pounds milk containing 1,003.7 pounds butter fat in one year.

heifer should be from twenty-four to thirty months old before freshening.

Guernseys were first imported during the early part of the nineteenth century but not until the latter half of the century were many cattle brought in. The growth of the breed was slow until the very last part of the century, so most of the development has occurred during the past thirty years. From the eastern states they have gradually spread to the west, Wisconsin now being a leading Guernsey state. Herds have been established in the south where they meet with considerable favor. No doubt they will make a substantial growth in the south as they are well fitted for the mild climate. The records of the breed are handled by the American Guernsey Cattle Club,

Peterboro, New Hampshire. The last volume of the herd book indicates that 50,000 bulls, 82,000 cows have been recorded since the Registry was established in 1877.

The Ayrshire breed.— This breed had its origin in Ayrshire, Scotland. The climate is rugged with severe winters and mild summers. The land is rolling and much of the soil is of only average fertility. Small grains and hay are the chief crops.

Fig. 154.—Ayrshire bull. Strathglass Gold Chink. A famous showring winner.

The cattle are grazed on the hills in summer. Historical records show that cattle of dairy type existed in the section previous to the establishment of this breed. During the latter part of the eighteenth century these cattle were improved by the introduction of Teeswater bulls. The red or brown and white color was established at this time and has continued as the breed color. Many brown and white cattle exist at present in Scotland.

The first Ayrshires coming into the United States came to Massachusetts about 1825. They met with much favor and grew to occupy a prominent place in New England. Other importations followed from time to time but not to the same extent that other dairy breeds have been imported.

Characteristics of the breed.— The Ayrshire is of meduium size compared with the other dairy breeds, mature bulls weigh-

ing from fifteen hundred to two thousand pounds. The modern show-ring type are larger than the type existing twenty years ago in this country. Mature cows weigh from one thousand to fourteen hundred pounds. In color the breed is red and white or brown and white. There are many animals to-day that are nearly all white. Red occurs on the sides of the head and neck.

As a breed, they are more uniform in type than any other

FIG. 155.—Ayrshire cow. White Heather of Torr. Grand champion Eastern States Exposition 1919.

dairy breed. Their lines are straight and features clean cut. The medium to long upright horns are a striking feature of the breed.

They are a little slower to mature than the Jersey or Guernsey and have a tendency to carry more flesh. As grazers on rough rolling pastures they are superior, excelling the other dairy breeds. They are very stylish and active. They are hardy and rugged making them a desirable farmer's cow.

They are more uniform in type of udder than any of the dairy breeds. Formerly they were criticized for having fleshy udders and small teats but these faults are rapidly being corrected.

As milkers the breed ranks next to the Holstein in quantity. While the milk is not as rich as that of the Channel Island breeds, it is superior in quality to that of the Holstein, making

the Ayrshire a splendid cow for the dairyman that retails his milk.

The interests of the breed are centered in the Ayrshire Breeders Association, organized in 1875. Offices at Brandon, Vermont. The Herd Register indicates that 21,448 bulls and 50,888 cows have been recorded to date.

The Holstein-Fresian.—The Holstein-Fresian breed of cattle is the oldest of our dairy breeds, having existed in its native country Freisland, Holland, for over one thousand years. This

FIG. 156.—Holstein bull. Iowana Sir Ollie. Grand champion National Dairy Show 1919.

is a low flat country noted for its abundant production of grass, hay and roots. The favorable climatic and food conditions have made possible the development of a very large, heavy milking breed.

In size the Holstein is the largest of the dairy breeds, mature bulls weighing from eighteen hundred to twenty-five hundred pounds and mature cows from twelve hundred to eighteen hundred pounds. As they grow so large they do not mature as early as some of the smaller breeds. In color they are black and white. In their native country red and white frequently occurs. It is not infrequent that red and white calves are born from black and white stock in this country. However, the Holstein-Fresian

Association of America stipulates that for registration animals must be black and white which prevent the registration of any off colored calves.

In milk production this breed is supreme, no other breed comparing with them in quantity, but the percentage of butter fat is low. The average for the breed being about 3.4 per cent.

The Holstein was first brought to this country by Dutch settlers who established themselves in New York State late in the eighteenth century. From there the breed has spread well over

Fig. 157.—Holstein cow. Minerva Beets. Six times grand champion at National Dairy Show.

the United States. It is especially strong in the north central states and northeastern states. It has never gained the foothold in the southern states that the Jersey has, although some good herds have been established. No doubt the breed will gain in the southern states as the dairy industry develops there.

The breed is generally popular throughout the sections where dairy cattle are kept. The ability of the cows to produce so much milk makes them highly desirable in the sections where pastures are good, and there is a demand for market milk.

In New England where oxen can be used advantageously on many farms, one finds many high class teams of Holstein steers.

Their size and strength coupled with ability to walk at a good rate makes them desirable oxen.

The calves make excellent veal as they grow rapidly and fatten readily. As beef cattle they do not rank high as the waste is great in slaughtering, and carcass lacks quality when compared with the beef breeds.

The interests of the breed are handled by the Holstein-Fresian Association of America, established in 1885, with headquarters at Brattleboro, Vermont. Up to the present time 259,900 bulls and 481,760 females have been recorded.

Dutch belted cattle.— This is a breed of dairy cattle that has existed in Holland for about three hundred years. The striking thing about them is the characteristic color, a white band extending around the body between the hips and shoulders, the remainder of the animal being black. The characteristic is so firmly impressed on the breed that animals often transmit the belt to their offspring when mated with animals of other breeds. In their native home they are known as Lakenfeld cattle. The conditions under which the breed has developed are very similar to those of the Holstein. However, it is evident that attention has been paid to the color markings rather than to efficiency as dairy cattle. As a breed the cows do not produce rich milk; so corresponding quite closely in quality to that of the Holstein and the average quantity is below the average for the dairy breeds.

In size they are about the same weight as Guernseys but are a little longer of leg and rangy throughout. They mature about like the Holstein. They were first imported in 1838, coming into New York State. Other importations followed about 1850, but none have been brought to this country in recent years, as the breed has never succeeded in gaining general favor. The interests of the breed are looked after by the Dutch Belted Cattle Association of Amrica, with headquarters in New York City. The interest in the breed is low at the present time.

French Canadian.— This is a small breed of dairy cattle that originated in Eastern Canada. They are called Canadian cattle in their native home. No doubt the breed originated from foundation stock brought to Canada by early French settlers. Although a little smaller, the breed resembles the Jersey very much in breed, character and milk production. It is very reasonable to expect that the source of foundation blood was much the same. The weight of mature bulls is from one thousand to twelve hundred pounds and of cows from six hundred to nine

hundred pounds. The color is usually a fawn or brown, quite similar to some families of Jerseys. The milk is about as rich as that of the Jersey but, as the cows are somewhat smaller, the average production is not so high.

These cattle have not gained a strong foothold in the United States, although they are found in small numbers in Northern New England and New York State. They are very hardy little cattle, possessing good grazing ability and meeting the condi-

FIG. 158.—Milking Shorthorn bull. Waterloo Clay. Famous showring winner.

tions of the small farmer of limited means in the rugged climate of their native country.

Kerry cattle.— This is the smallest of the breeds of cattle. The Kerry had its origin in Ireland under very adverse food conditions. This is clearly demonstrated in the small size and late maturity of the breed. The size is increased and age for maturing lowered when animals are transferred to more favorable climatic and food conditions. In color they are a reddish brown or black, and they have characteristic medium length, upright horn. They are short-legged, low set cattle. In their native country they are kept as individual family cows rather than in large herds together, and are often forced to exist on a very short feed supply. They are quite efficient milk producers considering their size, and the milk is of good quality. While a few have been imported they have never gained an important

place in America and probably never will. The interests of the breed in this country are handled by the Dexter Kerry Cattle Club, Columbus, Ohio.

Dual purpose breeds — *Milking Short-horn.*— Since the establishment of the Short-horn breed of cattle about two hundred years ago there has existed a strain of distinctly dairy type possessing remarkable milk producing ability. The cattle from which the breed originated had been noted for milk production so the characteristic was well established. In color markings

FIG. 159.—Milking Shorthorn cow. Doris Clay. Milk record 16,425 pounds, 61,826 pounds of butter fat.

they are the same as the beef type of Short-horn but in general the type is different, being more of the angular dairy conformation. The colors are red, red and white, white, and roan. The mature bulls often average two thousand to twenty-five hundred pounds and the cows fifteen hundred to eighteen hundred pounds. As milkers the cows often show remarkable ability. Volumes I and II of the Milking Short-horn Year Book gives the records of 427 cows averaging 8823.9 pounds of milk each on yearly test. The milk is medium in richness.

The breed was first brought to this country during the latter part of the eighteenth century and they gradually gained a strong foothold as farming moved westward with the opening

of the new lands. For many years they were distinctly the farmer's cow and occupied a prominent place in the early dairy industry of the country. With the depression in beef prices and the advance in demand for dairy products, they have gradually been displaced by the distinct dairy breeds, in the more favorable dairy sections. With the more recent advance in beef prices much interest is being revived and herds are being established

FIG. 160.—Brown Swiss bull. Gallatain Brownie. Grand Champion National Dairy Show 1919.

in remote sections where pastures are good and the possibilities of marketing cream, butter and cheese are favorable.

The beef value of this breed is a strong point in its favor. The cows fatten readily when dry and the quality of carcass is excellent. Steers of this breed when placed in the feed lot make good gains and at slaughter dress out a high class carcass of excellent beef. While they do not carry as much fat as the distinct beef type they carry sufficient for first class retail trade. There is a good demand for the feeders as well as for the finished cattle.

In grazing ability the breed ranks high. Many herds are maintained in good flow of milk on pastures alone in summer. Calves, sired by a Milking Short-horn bull out of grade cows, make excellent veal and bring good prices in the market.

The interests of the breed are centered in the American Short-horn Breeders Association established in 1882 with headquarters in Chicago.

Brown Swiss cattle.— As the name indicates, this breed originated in Switzerland. The Brown Swiss has existed in its native country as recognized breed for several centuries. They are large, strong, thick fleshed heavy boned cattle, possessing considerable ability to produce milk, consequently they meet the

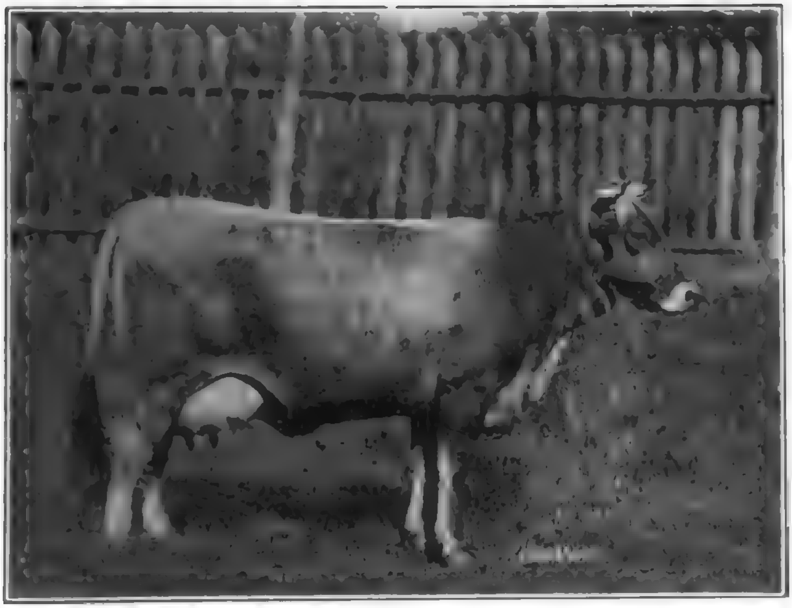

Fig. 161.—Brown Swiss cow. Betty of Lake View. Grand Champion National Dairy Show 1919.

dual purpose requirements. The ability of the cows as milkers in their native country as well as in America has given the breed quite a strong following in dairy sections. They are now classified in the National Dairy Show and in recent years have made an excellent showing. In size the mature bulls usually average from fifteen hundred to two thousand pounds and the cows from twelve hundred to sixteen hundred pounds. They mature at about the same age as the Short-horn.

The grazing ability of the breed is excellent, due to the conditions that they have been kept under for generations.

As beef cattle they do not rank high due to the heavy bone and large waste in slaughter. The calves make excellent veal as they grow fast and fatten readily. Bulls of the breed used

on grade cows would greatly improve the quality of the calves for veal. In milk production the breed ranks reasonably high. Many heavy producing cows are found and the milk is above the average in butter fat. The breed is very uniform in type and color, the majority of the animals being a uniform solid brown. Occasionally, animals of lighter or darker brown occur, but they are not common. White markings are decidedly uncommon.

They were first imported into the United States in 1869. Several importations have followed but these cattle have not

FIG. 162.—Red Polled bull. Teddy's Best. Champion Red Polled bull.

been imported or bred to the extent that the leading dairy breeds have. They are distributed quite well over Europe where they are valued highly.

The American Brown Swiss Breeders Association attends to the registration of these cattle. The organization was established in 1880. Headquarters at Beloit, Wisconsin.

Red-polled cattle.— This breed of cattle originated in Norfolk and Suffolk, England. The cattle of these two counties were interbred resulting in the establishment of the breed about the middle of the nineteenth century. The hornless character has always been a striking feature of the breed. Their uniform red color, coupled with smooth clean cut even fleshed type has been a strong point in their favor. They are of medium size, the

mature bulls ranging from sixteen hundred to twenty-two hundred pounds, and the cows from twelve hundred to sixteen hundred pounds. As grazers the breed ranks high, and they are especially well suited to the rolling pastures of the Eastern and Central States. Many cows of the breed are superior milkers and the percentage of the butter fat in the milk is above the average, making them desirable cows for the farmer located where he hasn't a ready market for whole milk. As beef cattle they rank well. The cows fatten readily when dry and the steers dress out an excellent carcass of high class beef. Although rated as a

Fig. 163.—Red Polled cow. Jean Duluth Millie. Record 519.9 pounds butter fat in one year.

dual purpose breed, the steers have made a creditable record in competition with the beef breeds in the slaughter trials both in this country and in England.

As feeders the steers are always in demand as they gain rapidly and smoothly so when finished they bring a good price in the market. The prepotency of the bulls is a valuable point in crossing on grade stock as they usually transmit the red color, polled character, and smooth even type.

The breed was first imported in 1873. Other importations followed for several years, but none have been brought in during recent years. The breed is quite well distributed over the Cen-

tral West and North Central States but the interest seems to be lagging at the present time. The breed possesses many desirable points and it would seem that they justify more interest than is being taken in them.

The American Red Polled Cattle Club was organized in 1883. The headquarters are now located at Gotham, Wisconsin.

The Devon breed.— This is a very old breed of cattle. They originated in Devon and Somerset, England. This is a very rolling section, well suited for grazing but not very good for farming. The type of the cattle has been fixed for many generations so the breed is very uniform. In size, the mature bulls weigh fourteen hundred to eighteen hundred pounds and the cows from one thousand to twelve hundred and fifty pounds. They are of a uniform deep red color with white sometimes occurring on the udder. The horns are of medium length with an upright curve.

They are very superior as grazers, having been kept on rolling pastures for generations. In type they possess smooth, even straight lines and are well proportioned with a medium short leg. While they are not a thick fleshed breed they are very even fleshed and when fattened produce very high class beef. Well finished steers often dress out a high percentage of fine quality of beef. As milkers the cows rank very well. Their ability to do well on rough pastures makes them well suited to some of the hilly sections of the United States. The milk is above the average in percentage of butter fat.

The Devon does not mature as rapidly as some of the other breeds.

They were first imported to this country during Colonial times, and for some years were quite popular in New England. However, the great demand for milk and the low price of beef caused the decline of all the beef and dual purpose breeds in this section and the Devon has not made a recovery. There are a few herds remaining, and some good herds are found in the Middle Western States, but the breed is declining at the present time in this country.

The interests of the breed are fostered by the American Devon Cattle Breeders Association, headquarters, Newark, Ohio.

Judging dairy cattle.—The ability to judge dairy cattle accurately and consistently is gained through continuous experience and study. It is true that some people have more natural ability along this line than others and by continuous practice they become expert in the selection of animals. There is no reason

why anyone who is interested in the subject cannot become a reasonably good judge if they will give it sufficient study. Keeping milk records and testing helps wonderfully as it gives the dairyman an opportunity to study the most productive types. In general all of the dairy breeds show the same clean cut, angular wedge form in contrast to the square built low set form of the beef animal. To judge a breed accurately, one must know the characteristics; such as size, weight, form, color, and all distinguishing points of the breed. One must also keep in close touch with breed, noting all advancement and improvement of type. It is necessary to study the official score card so as to put proper emphasis on the various parts. Some judges have an opportunity to become familiar with only one breed and confine their work to this breed. This usually happens with the breeder judge. Other judges make a study of several different breeds and have an opportunity to keep in close touch with these different breeds. Having no particular interest in any one breed, you have no breed prejudices and consequently can judge one breed as well as another if they possess natural ability and have given the subject sufficient study.

Selecting or judging a dairy cow.— To judge a dairy cow accurately, one must first consider the points that make the animal valuable from a dairy standpoint. To be a good dairy cow she must be an efficient milk and butter producer.

Breeding for dairy production for generations has eliminated the non-essentials in form and emphasized the essentials. For instance, the dairy cow that produces heavily for a long period must possess a strong constitution as shown in a well developed chest. She must be a heavy feeder, indicated by a deep well sprung middle. To be a good milker, she should carry a large, soft, pliable, well-formed udder; and to be efficient, she should possess quality throughout in hide, hair and bone. A symmetrical balance of all essential parts is desirable.

Detailed description of a good dairy cow.—

Size.— Meeting the requirements for the breed.

General form.— Angular wedge shape, body deep.

Head.— Lean, clean cut, good proportions, broad forehead, prominent eyes, dished face.

Large nostril.— Broad muzzle, strong jaw.

Neck.— Lean, thin, good length, and clean cut.

Shoulders.— Lean and laid in close at the top, giving sharp withers.

Chest.— Full in front, good width between front legs, well sprung back of the shoulders.

Back.— Straight and strong carried back to tail setting.

Middle.— Deep well arched ribs, giving capacity for feed.

Loin.— Good width and carried strong.

Hips.— Broad and angular.

Rump.— Broad and level showing strength and capacity.

Thighs.— Lean and clean cut, allowing ample room for udder.

Legs.— Straight and strong.

Udder.— Well developed front and rear with teats of good size placed squarely. Quality of udder soft and pliable.

Milk veins.— Large, and crooked.

General quality.— Clean cut features. Soft mellow skin and fine soft hair, clean cut bone.

Faults to avoid in selection of a cow.— Long narrow heads, narrow chests, shallow body, short heavy neck, coarse withers, sway back, narrow hips, steep rump, flat ribs, unbalanced udder, fleshy udder, small teats, crooked legs, and coarse hair, hide and bone.

Judging dairy bulls.— In general, the dairy bull resembles the dairy cow in conformation except that he shows masculine character and the cow shows feminine character.

The same general plan should be followed in judging. The bull should represent the breed in general character. He should be strong, rugged and masculine. He should be well developed in the chest insuring a good constitution, also in spring and depth of rib indicating a good feed capacity. Masculinity is shown in a clean cut strong well proportioned head, also well developed neck and crest. The shoulder should be strong but smooth and laid in nicely at the withers. The chest should be well developed back of the shoulder. The back should be straight and strong. Ribs well sprung and deep. Hips strong, rump level and tail set level. The legs should be of medium length and properly set. Crooked legs are to be avoided. It is unreasonable to expect a bull to transmit good conformation to his offspring if he does not possess it himself. In the selection of a breeding bull, take the one showing the most desirable conformation coupled with heavy production in his ancestry.

A good looking bull with poor production records back of him will prove to be a detriment rather than a help in the good producing dairy herd. Much emphasis should be placed on both type and production in the selection of the herd bull.

DAIRY CATTLE MANAGEMENT

Management of the herd bull.— The herd bull must be kept in good physical condition if his usefulness as a sire is to be realized. Many people fail to recognize the importance of keeping the bull in good strong healthy condition. The value of a sire in breeding will depend largely on how he is managed. From birth the bull should receive a ration furnishing an abundance of muscle and bone building material so as to insure first class development. Exercise during the growing period is especially important. As the bull reaches maturity, all sudden changes in feeding and management should be avoided. He should be sheltered in roomy, clean, well ventilated quarters, preferably a good-sized box stall connected with the lot so he can go out and in as he wishes. Buildings and fences should be strong and secure to prevent the bull breaking out.

If the bull is active he may not need any extra exercise but if he has a tendency to get lazy it may be necessary to give regular exercise in the yoke or tread mill. A mature bull can just as well do considerable regular work and be much better as a breeder for it. Bulls that have become uncertain breeders often become prompt sure breeders as a result of regular work.

In feeding the bull his needs must be studied. If he works he will need more than if he remains idle. A variety of feeds is far better than the same nutrition found in only one or two feeds. Bearing in mind that he must be kept in good strength and vigor, the ration should contain some legume hay if possible. Clover or alfalfa hay is very desirable along with some corn fodder or silage. A good grain mixture is corn meal or hominy three parts, ground oats three parts, wheat bran three parts, linseed meal one part, and feed just sufficient to keep the bull in good thrift. Care should be taken to avoid getting the dairy bull too fat or allowing him to get too thin. The health of the bull should be carefully guarded. He should not be allowed to serve cows that have aborted, until they have been cleaned up and are free from the disease. If through accident or carelessness he does serve such a cow he should be thoroughly washed up with a mild disinfectant solution, to prevent him spreading the disease to other cows. He should be tested regularly for tuberculosis and discarded as a sire if found diseased, as it is not reasonable to expect strong vigorous healthy offspring from diseased parents. The secret of success in herd bull management is plenty of exercise, careful handling, and a reasonable amount of good, clean, wholesome feed.

Management of the dairy cow.— The average dairy cow is fully mature, as far as growth is concerned, when she is five years old. The heaviest production usually occurs during the fifth, sixth, seventh, and eighth years.

The length of gestation period of the cow is 283 days. This makes it possible for her to produce a calf every year and produce milk from nine to eleven months each year. Every dairy cow should have a rest of from four to ten weeks every year. The age at which first calf is born will depend somewhat on the breed, as indicated in the chapter on breeds. If the heifer is well grown she can be rebred safely in ten to twelve weeks after calving, which will bring her second calf about one year later than the first. This plan can well be followed allowing the cow to calve every twelve months or thereabout. A cow should be well fed, when dry, to insure proper nourishment for her unborn calf and to have her in good condition at calving time.

The cow that calves in good condition has an abundance of reserve for heavy production during her lactation. The cow that calves thin in flesh, starts off at a serious disadvantage. Cows should have regular exercise when dry to maintain their strength and vigor. Laxative feed, such as silage and clover hay, are good feeds. A little linseed meal in the grain ration is desirable. Care should be taken to avoid constipation at calving time. If constipation does occur right at the last, the best treatment is to dissolve one pound of Epsom salts in a quart of warm water and give as a drench. This will usually rectify the trouble and help to reduce any feverish condition of the udder.

The cow should have a good, clean, comfortable stall in which to calve. If all goes well the calf will be delivered within an hour or two from time the first labor pains appear. If the calf does not come within a reasonable time, an examination should be made by some one who understands such work and if necessary assistance given. The normal presentation of the calf is front feet first with the head extended along the front side of the legs. If the presentation is not normal the services of some one skilled in handling such cases should be secured at once.

A normal calf will be on its feet within an hour or two after birth and is usually anxious to suck. The good herdsman will be on hand to assist the calf in getting the first milk which is quite essential to clear and regulate the bowels.

Experience has taught us that much trouble regarding milk fever can be avoided by not milking the cow out during the first twenty-four to thirty-six hours after calving. The calf can

remain with the cow for three or four days when it should be taught to drink milk from a pail if it is to be raised. If there is no fever in the udder the milk will be suitable for food by the sixth day. The cow should be fed carefully during the first few days and if she recovers normal condition the ration should be increased steadily up to the amount the cow is capable of consuming without digestive disturbance. The feeder should study his cows carefully and watch them closely. The most economical milk production occurs during the first months after freshening; so the cow should be supplied with all the feed she can handle.

Feeding dairy cows.—If possible, corn silage should be utilized as it is a nutritious succulent feed, furnishing nutrition in the cheapest form when put up in proper condition. There is nothing more suitable to feed with corn silage than either clover or alfalfa hay. Such hay is rich in muscle and bone building material and is excellent for the milking cow. The grain feeds that can be utilized along with corn silage and clover or alfalfa hay will be determined largely by the feeds available, and the market price. A grain ration that might be suitable in one state might be too expensive, or not possible in another. A very good rule to follow in herd feeding is to supply an average of ten to twelve pounds of good legume hay, along with thirty to thirty-five pounds of silage per cow daily, and for grain feeding one pound of grain to three and one half pounds of milk produced. Some cows will do better than others and the feeder should determine the ability of each cow and feed accordingly.

If cows are on good pasture with plenty of grass, and not too much travel, they usually refuse hay and silage; if the pasture is extra good they sometimes refuse grain feed for a time.

The observing feeder will watch closely and feed grain silage and hay as the shortage of pasture requires.

In making up a grain ration for cows it is usually best, if at least three or four feeds can be used in a mixture as it adds variety which is an important factor in keeping cows on feed for a continuous period. Ordinarily corn, oat, barley or wheat by-product feeds are utilized along with linseed or cottonseed meal to make up the ration for the dairy cow. Such rations possess variety, as the feeds come from different plants. Roots can also be used to advantage if silage is not available. Carrots, parsnips, mangel and sugar beets are all good. Dried beet pulp, a carbohydrate feed, is very good and can be fed wet in the place of silage or along with silage.

For best results, the silage should be made from corn that is

allowed to come practically to maturity; as such corn carries a maximum amount of nutrition and the silage will not be so strongly acid. Immature corn makes an acid watery silage, low in feed value. Spoiled feed should always be avoided as it usually results in digestive disturbance and loss of milk flow.

DAIRY RATIONS

Good rations for Dairy Cows, of 1,000 lbs. weight, milking 30 to 35 lbs. per day.

Ration No. 1:	
Clover hay	12 lbs.
Corn silage	32 "
Ground oats	2 "
Wheat bran	3 "
Corn and cob meal	3 "
Linseed meal	1 "
Ration No. 2:	
Alfalfa hay	10 lbs.
Corn silage	32 "
Gluten meal	3 "
Wheat bran	2 "
Ground oats	2 "
Corn meal	2 "
Ration No. 3:	
Mixed grass hay	14 lbs.
Corn silage	35 "
Wheat bran	3 "
Ration No. 3—(Continued):	
Gluten meal	3 lbs.
Ground oats	2 "
Cottonseed meal	2 "
Ration No. 4:	
Mixed hay	14 lbs.
Corn stover	12 "
Gluten meal	3 "
Wheat bran	3 "
Ground oats	3 "
Linseed meal	1 "
Ration No. 5:	
Mixed hay	16 lbs.
Beets or carrots	30 "
Wheat bran	3 "
Corn meal	3 "
Ground oats	3 "
Cottonseed meal	2 "

Raising calves.— Nearly all dairy calves are taken from their dams when they are only a few days old and fed from a bucket. Most calves learn to drink readily if started by the time they are a week old. The calf that sucks its mother for a few days usually starts off nicely. When separated they will usually learn to drink more readily if allowed to get hungry. Care should be taken to avoid over feeding. It is usually better to feed less at a feed and give them three or four feeds per day for two or three weeks. The average young calf should not drink over four or five pounds of milk at a feed at first. The amount should be increased as the calf grows older, and should be cut down if digestive trouble arises. It is best to feed the new milk from the mother while it is still warm until the calf is three or four weeks old, at which time skim milk can be gradually substituted, taking two weeks for the complete change.

Calves will usually begin eating grain feed and hay when about three weeks old. Some will begin earlier, and such feed should be supplied to bring about normal development. An excellent grain mixture for calves is oats three pounds, wheat bran three pounds, corn meal three pounds and linseed meal one

pound. A convenient feed box should be provided and some of the grain put in the calf's mouth as soon as the milk is finished.

A little feed in the box will soon attract the calf and it will soon be eating regularly. Stale feed should not be left in the box. If a convenient rack is provided, the calf will soon learn to eat hay. The best to supply is a fine grade of clover or alfalfa as it furnishes the necessary muscle and bone building material.

Calf stables.— Calves can be kept together in large pens or in small single pens. In either case the stable should be light, clean, warm and well ventilated. There are advantages in the single pen system and it is generally preferred as the feeder can observe the calf more closely. Winter grown calves can be grown more cheaply to maturity than spring calves.

The fall calf is usually sufficiently developed to do well on pasture by the following spring, whereas the spring calf is not old enough to subsist on pasture the first season. Many are weaned from milk and turned out too soon. Such calves, coming into the stable in poor condition in the fall, seldom do well the first winter unless given extremely good care.

Skim milk should be fed if possible until the calf is six or seven months old. If a supply is available it can be used to advantage longer. The cost of growth and gain is much less the first year than later which emphasizes the urgent need for good feeding and care during the early life of the animal. The breeder should give the calves the best of feed and care as his success will be determined by their growth and development.

DISEASES OF THE COW

By J. H. Hewitt, D.V.M.

Bloating.— Caused by spoiled food, clover, alfalfa. Animal is bloated more on left side, may be in much pain. Severe cases should be treated by a veterinarian who may have to draw the gas with a trocar. Mild cases may be treated by giving two pounds of Epsom salts and one tablespoonful of ginger or one ounce turpentine in oil. A smooth stick arranged like a bit on which the cow can chew will often start the gas. For sheep give one-half pound salts. Dissolve salts in hot water.

Off feed is indigestion caused by overfeeding, poor or spoiled food, sudden change of foods. Clean out bowels with two pounds of Epsom salts and one tablespoonful ginger for grown animal. Also give one tablespoonful three times daily of the following:

Sodium sulphate, sodium bicarbonate, powdered nux vomicae, powdered gentian, salt, four ounces each.

Losing cud means that the animal is sick; give treatment as for off feed. If animal is no better call a veterinarian.

Scours or diarrhœa; constipation.—See Horse.

Choking is generally by apple or potato lodged in food pipe. Locate object if possible and work it up into the throat where it can be removed by the hand. If this fails it may be carried down by a piece of garden hose, using gentle pressure. Do not use a stiff, straight instrument. A small amount of oil will sometimes start the obstruction.

Garget comes on frequently in cows that are highly fed, especially on concentrated food. Reduce heavy feeds, as gluten. Milk frequently. Open bowels by one pound of Epsom salts, repeated if necessary. Also give one teaspoonful of saltpetre three times daily for one week. One-half ounce F. E. poke root three times daily is excellent.

Inflammation of the udder is a condition in which the udder is swollen, hot and painful. Bathe frequently with hot water followed by an application of melted lard or skunk oil. Also give two pounds of Epsom salts and milk frequently.

Chapped and sore teats.— Caused by dirt and cold moisture. Apply compound tincture benzoin once or twice daily. Carbolic salve is good.

Blackleg is caused by a germ or bacteria. Most cases affected die. Usually begins with a lameness in leg, the part swelling and crackling as hand is rubbed over skin. Animal has high fever. Dead animals should be deeply buried, covered with quick lime, or burned. Vaccinating with blackleg vaccine is a preventive.

Milk fever.—A disease which occurs near calving time, or shortly after. Cows in good condition and large milkers are most susceptible. At first the cow is uneasy, then loses control of the hind parts and finally goes down unable to get up, lying on left side with head on right flank, groaning as if in paint. *Treatment:* Wash and disinfect udder and teats, then inflate udder with sterilized air. As a preventive keep udder distended with milk for a day or two.

Mammitis.—Inflammation of the udder from infection, injury, or too concentrated food. Clean out bowels with two pounds Epsom salts and one ounce ginger. Follow by daily doses of one ounce saltpeter. Also give one ounce F. E. poke root in a pint water morning and evening. Bathe udder with hot water and apply an oil or ointment (lard is very good).

To stop bleeding after dehorning.—Tie a cord tightly about the base of the horns.

CHAPTER XVI

CARE OF MILK ON THE FARM

BY H. T. BALDWIN, B.S.A.[1]

Milk is a highly perishable product which requires great care in production and handling to keep it in a wholesome condition. Whether it is sold as market milk or made into butter, condensed milk, or cheese, it is almost always used as a food and should be

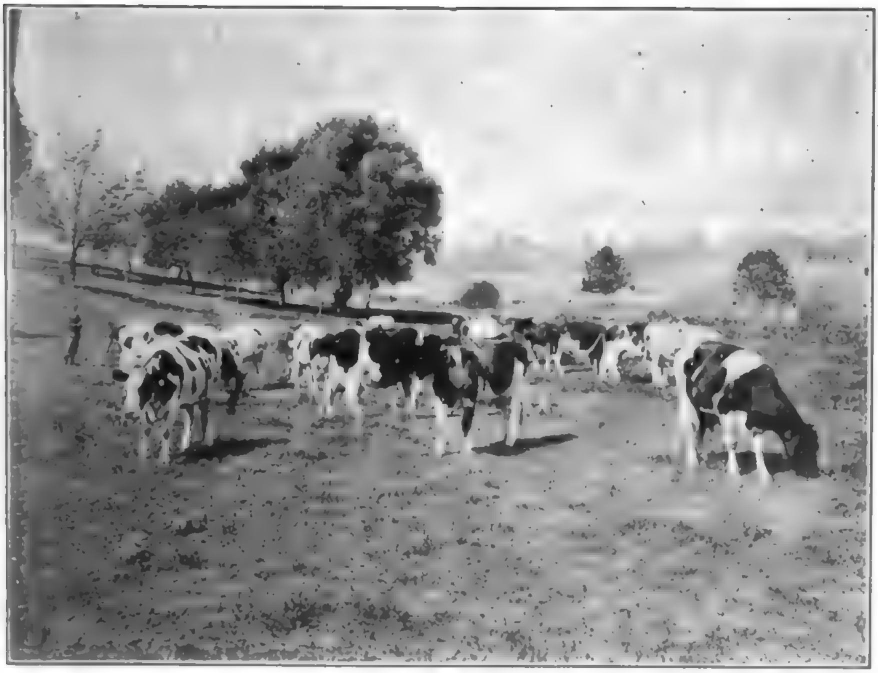

FIG. 164.—Clean cows give clean milk. A cow when left to herself chooses clean surroundings; a clean stable will aid her in producing clean milk.

kept free from contamination. Clean, pure milk of low bacterial count also keeps longer and generally brings a better price than milk filled with sediment and containing large numbers of bacteria.

Healthy cows give clean, pure milk. The dirt, sediment, and undesirable varieties of bacteria, which reduce the keeping quali-

[1] Dairy specialist.

ties and value, get into the milk after it has left the cow. How much or how little of these contaminating materials will get into the milk will therefore depend upon the dairyman.

How to keep down the bacterial count.—If the following suggestions are carried out, a milk of low bacterial count and little sediment will be produced:

1. Keep the barn clean.
2. Keep the cows clean; with a damp cloth wipe the udder and flanks before milking.

Fig. 165.—A clean herd means cleaner milk. Currying and brushing cows on a modern dairy farm.

3. Milkers should wash their hands often and milk with the "dry-hand" method.
4. Milk into a small-top milk pail.
5. Keep the milk cans covered.
6. Wash and sterilize with steam all milk utensils before using.
7. Cool the milk to fifty degrees F. as soon as possible after milking and keep it cold.

ROUTINE OF HANDLING MILK

Straining.— After the milk is drawn it should be taken at once to the milk house to be strained and cooled. Straining is best done through a layer of absorbent cotton between two cloths, or through special "filter cloth."

Straining the milk takes out dirt and sediment but does not remove the bacteria. There are many kinds of strainers in use and these vary greatly in efficiency. The following are the most common materials used for strainers, arranged in order of efficiency: Absorbent cotton, cheesecloth, two thicknesses; cheesecloth, one thickness, and wire gauze. Strainers made of wire gauze are the least efficient. Strainers of all types should be washed and sterilized after each using; otherwise the millions of bacteria which have collected on them will contaminate subsequent milkings.

At certain intervals the milk from each cow should be weighed and tested to determine her production and profitability.

Cooling.— When milk has been strained it should be cooled as soon as possible to a temperature of fifty degrees F. or lower. By cooling the milk soon after it is produced, the development of bacteria is checked, as bacteria multiply slowly at low temperatures.

Milk can be cooled more rapidly if it is first run over a cooler or aerator. Such coolers allow a thin film of milk to pass over a surface which is kept cold by means of cold water kept in circulation, or with water and ice. This takes the heat out of the milk and also some undesirable odors, provided the surrounding air is pure. From the aerator the milk may be poured into milk cans and set into tanks filled with cold water or ice. Milk should be kept covered while cooling and in storage. The cooling tanks are often made from concrete or of wood lined with metal.

Milk should be kept in ice water until started on its way to the station or plant.

Bottling.— Where there is not a sufficient quantity of milk handled to warrant the use of a bottling machine, a funnel will often serve the purpose of getting the milk into the bottle. The milk tank on most centrifugal separators can also be used by pouring the milk into the tank and using the faucet as a filling device. Milk bottles should be washed and sterilized before using, and the caps put on as soon as the bottles are filled. Bottled milk can be kept cold by packing in crates holding from six to a dozen bottles and filled with ice.

Utensils.— All utensils used in milk production and handling should be washed and sterilized after each use. Unsterilized milk pails, milk cans, strainers, etc., have been found to be one of the greatest sources of contamination. Directions for sterilizing utensils are given on page .

Separating the cream.— Where the cream is to be separated from the milk, the milk is put through the separating process immediately after straining. This makes it possible, where a centrifugal separator is used, to feed the skim milk to calves or other stock while it is still warm. For details see pages to

Gravity separator.— Where only a small amount of cream is handled, it is often separated by gravity. The cream is placed

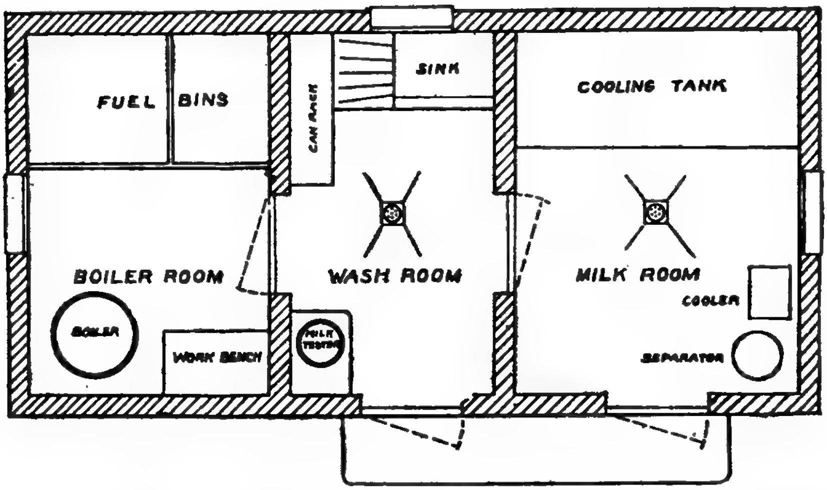

FIG. 166.—Plan of a milk house for a medium size dairy farm. Dimensions 10 feet by 8 feet 6 inches high in front and 6 feet 6 inches in rear. Outside covering should be building paper and sheathing or weatherboarding.

in deep cylindrical cans and the cans placed in cold water until the cream has risen to the top. This process usually requires from twelve to fifteen hours.

The milk house.— A milk house provides a place where dairy products may be handled in a sanitary manner. In planning such a house, avoid having rough surfaces and ledges where dirt may lodge. Windows and ventilators are of great importance in keeping the air fresh, and in summer all doors and windows should be screened. Plenty of water must be available and may be supplied by a regular water system or from an elevated tank fed by a windmill or engine.

Steam or hot water is very necessary for washing and steriliz-

ing milk cans and utensils. After washing, all such utensils should be scalded with boiling water or steamed.

The plan of a milk house shown is intended for a medium-sized dairy and may be enlarged or reduced to suit each farmer's conditions.

The building should have a good concrete floor, pitched to drain through a bell trap. The side walls should be plastered with cement on metal lathing as high as the windows. The remainder of the walls and ceiling may be covered with matched boards and then painted with a washable, white-enameled paint. A ventilating flue should extend through the roof from the ceiling. The windows should be hinged and set flush with the inside wall when closed.

The equipment consists of a one and one-half- to two-horse-power vertical boiler, which supplies steam to the sink and to the steam jet in the drain board; a galvanized-iron wash sink; a can rack; a Babcock tester; cooling tank; a milk cooler; and milk scales and separator.

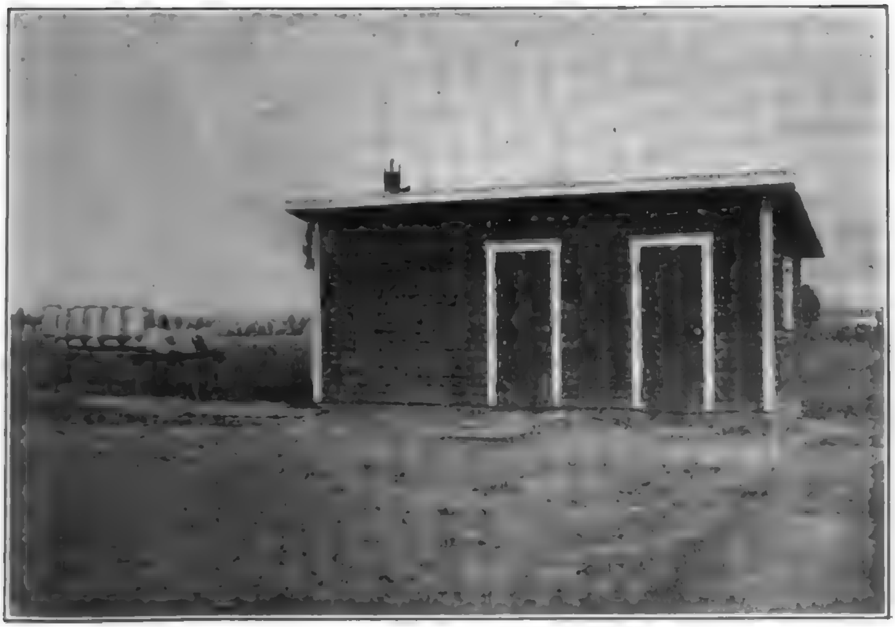

FIG. 167.—Outside view of a good type of milk house. The ground plan for this house is shown in Figure 166.

COOLING MILK ON THE FARM

Cooling milk and cream promptly and properly would prevent, to a large extent, the enormous losses which are occasioned by the souring of these products before they reach the market. All milk contains bacteria. These bacteria multiply rapidly at temperatures above fifty degrees F. No matter how carefully the milk has been produced, if it is not cooled immediately and kept cold, bacteria will develop and cause it to sour.

Surface cooler or aerator.— To obtain rapid and economical cooling, the milk or cream should first be run over a surface cooler. Best results will be obtained if each cow's milk is cooled immediately after milking, instead of waiting until all the milk is drawn. This will save considerable time, as all except the last pail of milk will have passed over the cooler by the time the last cow is milked. While most surface coolers require running water, some of the simpler coolers are fitted with a tank, in which either ice water or running water can be used. If cold water is available, the temperature of warm milk may be lowered from twenty-five to thirty-five degrees F., or very close to the temperature of water. Precooling in this manner saves both time and ice. From ten to fifteen gallons of water are required to lower the temperature of one gallon of milk to the temperature of the water.

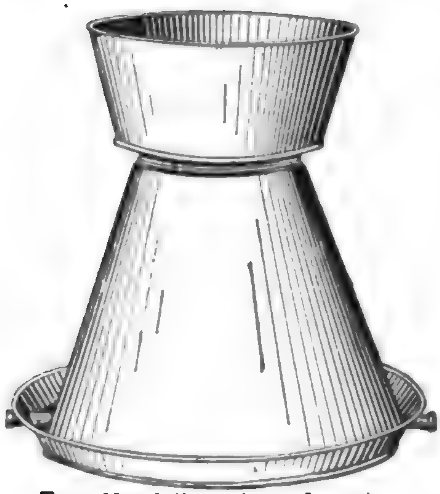

FIG. 168.—Milk cooler and aerator.

Types of coolers.— A simple type of surface cooler is shown in figure 168. The milk is poured into the upper bowl, which has a row of small holes around the outer edge of the bottom. The milk runs through these holes on to the surface of the conical tank which contains the water. As the milk coming down in fine streams hits the conical surface, it spreads into a thin film and is quickly cooled as it passes over the cold surface. Either running water or ice and water may be used with this type of cooler. If ice water is used, the contents of the tank should be stirred frequently with an agitator, to keep a supply of cold water near

the surface of the cooler. When the milk reaches the bottom, it is caught in a trough from which it drains into the milk can.

The type of cooler shown in figure 169 requires running water under pressure, as the water must pass upward through the cooler and out through a drain at the top. The warm milk flows downward from the supply tank over both sides of the cooler and drains off at the bottom. The coldest part of this cooler is at the bottom, so that the warm milk first comes in contact with the warmer portion at the top and comes in contact with colder portions as it passes to the bottom.

FIG. 169.—Insulated concrete cooling tank partially sunk in the cement floor; also a surface cooler in operation.

Coolers, like other milk utensils, require sterilizing after each using.

Cooling tanks.—While surface coolers are a great aid in cooling milk and cream, they do not complete the cooling process. A cooling tank is, therefore, necessary to cool the milk to a low temperature and hold it there.

Cooling tanks are generally constructed of concrete or of wood lined with a nonrusting metal. Such tanks must be watertight and should be provided with an outlet at the bottom to drain off the water when cleaning them. The walls should be sufficiently high to allow the upper level of the water to reach the necks of the milk cans, and the drain pipes should be arranged to hold it at this level. Narrow strips should be placed in the

bottom of the tank to hold the cans off of the tank floor and to allow cold water to reach the bottom of the cans.

Size of tanks.— The size of the tanks should be suited to the number of cans to be handled. However, as the quantity of milk varies from season to season and from year to year, it is advisable to divide the tank into two compartments. Too large a tank results in a waste of ice, while a tank that is crowded with milk cans does not provide space for sufficient ice to cool the milk. The tank should be placed in the milk house where it will be protected from the sun in summer and from the extreme cold in winter.

Use of ice.— Ice should be put in the cooling tank long enough *before milking* to bring the water to a low temperature by the time the milk is ready for cooling. The amount of ice necessary to cool and hold each gallon of milk at fifty degrees F. will vary from one and one-half to two and one-half pounds, provided the milk was precooled and the water in the cooling tank was forty-five degrees F. when the milk was put in. Where milk is not precooled, about four pounds of ice will be required per gallon of milk.

Well or spring water for cooling milk.— If well water or spring water is used for cooling milk, the water should be pumped from the well or spring direct to the cooling tank; otherwise the water will be too warm when it arrives at the tank. The inlet should be at the bottom of the tank, allowing the water to flow around the milk cans and out of the top.

Construction of tanks.— While wooden tanks have given good results in cooling, an insulated concrete tank is much more desirable. Such a tank is easily built and can be set partly in the ground. When the tank is set low, cans of milk can be lifted in or out with very little effort. The total thickness of the walls of an insulated concrete tank should be eight inches, divided into two walls, the outside being two inches, then two inches of good insulation, and the inside wall four inches thick. The concrete mixture should consist of one part Portland cement, two parts clean, sharp sand, and four parts broken stone or gravel. For the purpose of waterproofing, hydrated lime equal to ten per cent by weight of the cement, should be added to the mixture. The insulation, which generally consists of some commercial fibre insulator, should be coated with and set in hot asphalt, which should be allowed to become thoroughly dry before the inner walls of the tank are put up. The inside walls should be very carefully troweled to insure a smooth surface without projecting particles.

HINTS ON SHIPPING MILK AND CREAM

If milk reaches its destination in a sour condition, it generally means a total loss to the producer, so that every precaution should be taken to get it to the receiving plant in good condition. Assuming that the milk is cooled immediately after it is obtained, the following precautions will greatly aid in keeping milk sweet and in good condition.

Keeping milk cold.— Milk should be kept as cold as possible

FIG. 170.—Type of motor truck used in Virginia to insure quick hauling of milk to the shipping station.

before and during shipping. The cans of milk should be kept in cold water or ice water — if ice is obtainable — up to the time of starting them for market. Milk cans should be kept out of the sun if possible. If transported in a wagon or a truck, a tarpaulin thrown over the cans will aid in keeping out the heat.

Where milk is transported long distances to market in the summer time, covers or jackets made of felt or other insulating material are sometimes placed around the cans to keep out heat.

Special cans built with insulated walls can also be obtained. These cans are designed to keep the milk at whatever temperature it is put into the can. Milk must be cold before it is put into

these cans, and it is also advisable to cool off the inside of these cans before filling them with milk.

Bottled milk or cream may be kept cold during delivery by placing bottles in crates packed with ice. These crates are partitioned off, leaving a space for each bottle, and are usually lined with zinc.

Formerly, when nearly all cream was shipped to creameries in a sour condition, icing or cooling was not considered necessary. Many creameries, however, are now demanding a better grade of cream and, in some cases, sweet cream, and paying a higher price for it. This means that cream must be shipped oftener and kept cold. The same precautions recommended in cooling and handling milk will be found equally advisable in handling cream. When warm cream is added to cream from a previous milking, which has been cooled, it tends to increase the temperature of the whole mass and hasten souring. See that all cream is cold before it is mixed. Cream does not sour as quickly as milk, and thick cream does not sour as quickly as thin cream; therefore, milk should be separated to produce thirty or thirty-five per cent cream. Such cream sours slowly, is less bulky to handle, and leaves more skim milk on the farm.

Ice supply.— It rarely happens that water from wells or springs is cold enough in the summer time to cool milk to fifty degrees F. It is advisable, therefore, to provide a supply of ice for use during the summer. In general, from one-half to one ton of ice is required per cow to cool cream only, and one and one-half to two tons per cow if whole milk is to be cooled. In storing ice, fifty per cent more should be packed than is needed, to allow for shrinkage. One ton of ice will take up about forty cubic feet of space in the ice house.

Sterilize all containers and utensils.— Milk cans, milk bottles and utensils often appear clean after washing, but in reality contain thousands of bacteria. These containers should be both washed and sterilized.

Many progressive creameries wash and sterilize cans before they are returned to the producer, but this can not be depended upon and the dairyman should make certain by sterilizing them along with the other utensils.

Washing the cans.— Milk cans and utensils should be washed with warm water and sal soda or other washing powder, using a stiff brush. Wash until the greasy film has been cleaned off, then rinse with hot water.

Sterilizing with steam.— Where steam under pressure is

available, an outlet pipe is generally extended up through a table or rack so that it projects vertically through the surface about five or six inches. Cans or other utensils to be sterilized are placed upside down over this steam jet and the steam turned on. Forty-five seconds are required for sterilizing with live steam and the can is then removed, using gloves or cloth pads to protect the hands, and placed bottom side up to drain. As the cans are very hot, they dry quickly.

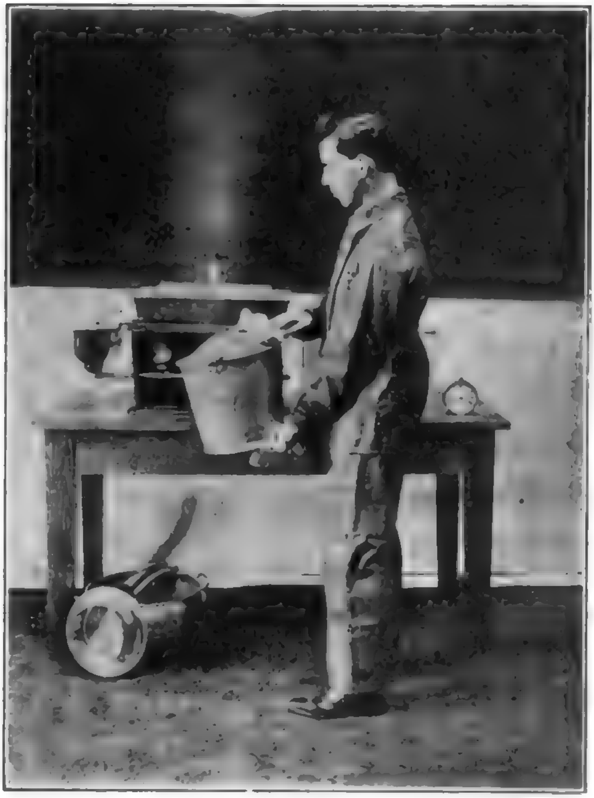

FIG. 171.—Simple and inexpensive steam sterilizer, consisting of a roasting pan with a special cover which can be made by any tinsmith.

Where a boiler is not available, a homemade steam sterilizer can be made from a roastingpan to which has been fitted a tight-fitting cover. The cover can be made by any tinsmith and has a small vertical pipe soldered to it at the center, which acts as a chimney for the escaping steam. In the pan is placed about one inch of hot water and the pan set on a hot stove. When the steam, which is tested with a thermometer, has reached two hundred and five degrees F., a can or other utensil may be placed over the steam jet and sterilized. It requires about five minutes for sterilizing where the steam is at two hundred and five degrees F. or over. A metal box should be constructed to fit over the sterilizing pan. This will provide a means for sterilizing strainer cloths, covers for milk cans and other small articles. When dry, place covers on cans, and set utensils where dust will not get on them.

Sterilizing with boiling water.— Utensils may also be sterilized by immersing in boiling water. This method requires a tank large enough to accommodate the largest utensil if complete sterilization is to be obtained. The utensils should be boiled for five minutes.

Care of cans.—The name of the owner should be painted on the milk cans, or a durable tag, giving name and address, should be securely fastened on the handle. Cardboard tags wear out quickly and should be inspected before each trip. Tops should be fastened on the can with heavy wire and locked with a padlock, the producer and receiver each having a key. This will prevent loss of covers and tampering with milk while on its way to market.

Cans which are rusty on the inside or from which the tin has worn off can not be cleaned properly and should not be used for shipping milk.

THE MILKING MACHINE

Economic value.— The main purpose of the milking machine is to save time and labor. Where herds are large, much time can often be saved by the use of the mechanical milker; also, where labor is scarce it takes the place of one or more milkers. On the other hand, where herds are small and labor is plentiful, especially if there are a number of boys on the farm, a dairyman would probably find it cheaper to milk by hand. In view of these facts it would be advisable for each dairyman who is considering the installation of a milking machine to make a careful analysis of his own particular conditions before making the investment.

The relative cost of hand milking and machine milking is a problem very difficult to work out, as these costs vary widely not only in different sections but on different farms in the same section. In general, however, herds of less than twenty cows can be milked cheaper by hand than by machine. This is, of course, not a hard and fast rule and does not mean that all herds of less than twenty cows should be milked by hand. For instance, one man living in a neighborhood where labor is scarce or high in price and without the help of a family would very likely find a mechanical milker economical.

The labor question.— Aside from lessening the cost of milking in large herds, the mechanical milker has a further advantage in that it tends to make the dairyman less dependent upon hired help.

In some instances, however, the man in charge of the dairy does not attempt to understand the operation of the machine, but depends altogether on hired labor to do the milking. Under such circumstances, the mechanical milker does not make the owner any less dependent upon hired labor, and if, upon installing, the owner has reduced the number of milkers, the machine may tend to make the dairyman even more dependent upon his employees than if he carried the usual number of milkers and milked by hand.

FIG. 172.—A milking machine ready for business.—*Courtesy of College of Agriculture, Cornell.*

Stripping after milking. — The cow with a normal udder and teats of uniform size can be most successfully milked with the machines. It is necessary, however, to strip every cow after milking with the machine. By stripping is meant the drawing of the last bit of milk from the udder. This is best done by milking with the hand in the usual way rather than by drawing the teat between the thumb and forefinger, as the word stripping implies. The stripping should be done as soon after removing the teat cups as possible. Whether the machine gets all the milk or not, stripping should not be neglected, for it enables the operator not only to be sure that all milk has been drawn, but also to come in contact with every teat in the herd at each milking, so that any abnormal condition of the udder or teat may be detected at once.

Before becoming accustomed to the machine, nervous cows may hold up their milk. Massaging the udder while the machine is on and careful stripping later will prevent the leaving of milk in the udder.

Some dairymen believe that no harm results from the practice of leaving the machine on the cow after all the milk has ceased to flow. Disregarding the fact that this might prove harmful to the more delicate cows, it is an uneconomic use of the milking machine, as it wastes time.

Speed in milking.— A great part of the value of a milking machine lies in its ability to save time. The more expert the operator, the more valuable is the machine. One man should handle at least two, and, if possible, three, units, and strip after them himself. The deftness of the operator has a great deal to do with the speed of milking, and each motion should be made to count.

System of operating.— Where more than three units are used, the following methods of operation are generally followed:

1. Each man handles two or three machines, does his own stripping and handling of the milk.
2. One man operates from four to six machines, an assistant doing the stripping and handling the milk.

The first method is ordinarily preferable, as it enables each man to become familiar with the machine and to know just how to handle it on each cow milked. In order that the mechanical milker may be a success, it is essential that the operator understand his cows as well as his machine.

Cows fresh in milk should be milked carefully until the tender tissues of the teats and udder become accustomed to the strain of milking.

Contagious diseases.— Cows having contagious udder troubles are best milked by hand until cured. In this case the hands should be washed in the same manner as is recommended for the teat cups. If milked by machine, the operator should carry with him a part of the sterilizing solution (as recommended for sterilizing teat cups and tubes) and a pail of clean water. After each affected cow has been milked, the teat cups should be dipped in the sterilizing solution and then rinsed in the water. Handling the units in this way should prevent the spread of udder diseases and meet the objection sometimes advanced that milking machines spread contagious diseases.

CLEANING AND STERILIZING MILKING MACHINES

Too much emphasis can not be placed upon the importance of properly cleaning and sterilizing the milking machine. To produce clean milk and avoid danger of spreading disease in the herd, the machine must be kept clean. To produce milk of low bacterial count requires great care in cleaning. For this purpose the following cleaning method has given good results:

Immediately after milking, the machine should be rinsed. This may be done by immersing the teat cups in a pail of clean water and turning on the vacuum, which will draw the water through the teat cups and tubes and into the bucket. A washing solution made by adding a small amount of washing soda compound to some hot water, may be drawn through the units in the same manner as outlined above, after which all parts should be thoroughly rinsed with hot water.

At least twice a week all rubber tubing should be disconnected and washed in a soda solution with the aid of brushes.

Between milkings the rubber parts must be kept immersed in some liquid, which for sanitary reasons must be sterile. The purpose of this is twofold. The solution will help to preserve the rubber, which must never be allowed to become dry, and it will check the growth of bacteria which might later contaminate the milk flowing through the tubes.

The preparation of this solution is one of the most important chores connected with the care of the milking machine. If it is to be of value, rather than an additional source of contamination, it must be kept clean and sterile. To insure this condition, the solution must be made up with sufficient strength to overcome the germs that enter with the tubes, etc., and it must be fresh. It is recommended that a new solution be made up daily and it never should be used over two days.

The "soak solution" may be made by using one of the commercial preparations recommended by the milking-machine manufacturer, or it may be made by the operator by following the directions here given:

1. Dissolve a twelve-ounce can of commercial chlorinated lime (it may be obtained at any drug store) in two gallons of water. Strain into a crock and keep covered in a cool place. This is known as the stock solution.

2. To make the soak solution in which the tubes and teat cups are to be immersed, put one-half glassful of the stock solution into every two gallons of water used. Use water enough to keep

the tubes completely covered. A large crock or wooden vat may be used for the purpose and it should be kept covered.

It is not advisable to attempt to sterilize by boiling the rubberware of the milking machine. However, the teat cups and rubber tubes can be rendered very nearly sterile by placing them in a tank of cool water and gradually heating the water up to a temperature of one hundred and seventy-five degrees to one hundred and eighty degrees F. and holding at that temperature for a half hour. They should then be removed and placed in a sterile solution until used again. This treatment is recommended if the dairyman is trying to maintain a very low bacterial count.

The vacuum-pipe line should be flushed out at least twice a month with hot water in which has been dissolved plenty of washing soda or washing powder. In this process the suction is used to draw the cleaning solution through the pipes.

In handling the tubes and teat cups the operator should be careful not to let any oil get on the rubber parts, for oil rots rubber quickly. Boiling water and steam will also shorten the life of rubber according to the amount of heat applied.

In producing milk of low bacterial count it is advisable to wash off the teats and udder of the cow and draw a little milk from each teat before applying the cups.

Appoint one man to do the cleaning. When one man is alone responsible, he will usually keep the machine in proper condition.

THE CREAM SEPARATOR

On a large percentage of the farms throughout the country, it has been found more advantageous to market the milk in the form of cream rather than to sell it as a whole milk. Under this system the milk is separated on the farm and the cream is sold at a local creamery or hauled to the shipping station for transportation to more distant markets. This method of marketing has several advantages. It saves much hauling by greatly reducing the bulk of the commodity to be handled. Also, the skim milk, which contains valuable feeding elements, can be fed to the calves or other young stock on the farm.

Types of separators.— Cream may be separated from the milk by gravity or by a centrifugal (mechanical) separator. Of these two methods the latter is by far the more efficient and economical. The gravity separation may be accomplished by the shallow-pan, the deep-setting or the water-dilution method. These systems were used exclusively in the past and are still in use in certain sections where dairying is undeveloped and on

farms where only a few cows are milked. In the first method, the milk is poured into shallow pans and allowed to set in a cool place for about thirty-six hours, during which time the cream rises to the surface. The cream surface, which is exposed to the air, often absorbs objectionable odors and flavors. The greatest disadvantage, however, is the loss of fat in the skim milk, which varies from 0.5 to 1.5 per cent.

The deep-setting method of separation is the best of the gravity systems, owing to the fact that a better quality of both cream and milk is obtained. As soon as milk is drawn from the cow, it is placed in a deep but narrow can, and the can set in cold water, preferably with an addition of ice, for twelve hours. The low temperature causes the cream to rise quickly and the separation takes place while the milk is still in good condition. However, by this method about 0.5 per cent of the butterfat remains in the skim milk.

The water-dilution method is probably the least used, as it results in a loss of butter fat equal to the shallow-pan method and has the further objection of adding a watery flavor to the cream and reducing the value of the skim milk by dilution.

With the centrifugal separator the separation is accomplished in a few minutes while the milk is still warm and perfectly fresh. This is a great advantage in getting a good quality of perfectly sweet cream. The skim milk also is more valuable when fed fresh and warm to calves and young stock. Furthermore, when the milk is fed soon after it is produced the chances of contamination are lessened and the bacterial content will ordinarily be much lower than when it is allowed to stand for a considerable length of time.

The centrifugal method also has the advantage over other methods of separating in that the thickness of the cream can be regulated at will simply by turning the cream screw.

The centrifugal separator skims to a very small fraction of one per cent, so that practically no butter fat is left in the skim milk. This, of course, results in a considerable saving and, unless the quantity of milk to be skimmed is very small, the separator is a paying investment. There is no hard and fast rule for determining the number of cows a dairyman should milk before it will pay him to buy a separator, but ordinarily, where the herd numbers more than four or five cows, the use of a separator would prove to be economical.

Size of separator.—The size of the separator required will depend on the number of pounds of milk produced. However,

in determining the size of separator that will meet the requirements of the herd it is well to remember that the herd will probably increase from year to year, and purchasing a separator with a slightly larger capacity than is actually needed at present will save the dairyman buying a new and larger machine later on.

Principle of centrifugal separation.—The centrifugal separator separates the cream from the skim milk by centrifugal force. This is made possible by the fact that the skim milk particles are heavier than the fat particles. The milk on entering the rapidly revolving separator bowl is forced to the outside of the bowl. As the skim milk particles are the heaviest they are thrown against the bowl walls, displacing the lighter fat globules and forcing them back toward the center, where they are drawn off as cream. The skim milk is collected from the outside of the bowl and removed through another channel.

CARE OF THE CREAM SEPARATOR

The cream separator is generally placed in the milk house or other room where the milk will not be exposed to odors and bad air while in course of separation. As most separators run at a high speed, they should be firmly secured to a solid floor or foundation in order to prevent vibration. If the separator is not so secured the frame will vibrate and cause the bowl to wabble. Under such conditions the separation of cream from the milk is not complete and considerable butter fat is left in the skim milk.

Foundation for the separator.—The cement floor is the best type of floor for the separator, as it does not vibrate and is easily kept clean and free from odors. If the machine is to be set upon cement, bolts should be embedded in the floor with enough of the threaded end exposed to allow washers and a nut. Space for the washers is provided so that they may be added or removed in leveling up the machine. If this method is used, careful measurement should be made to get the bolts exactly in the right place, for an error of a small fraction of an inch may necessitate resetting one or more bolts.

Good results have also been obtained by setting two four-by-four's or other solid timbers in the cement about where the base of the separator is to rest. Lag screws are then used to secure the separator to the timbers.

Where the floor is already laid, holes may be drilled, the bolts inserted, and hot lead poured into the holes until even with the surface of the cement.

If the separator is placed on a wooden floor, it can be secured to the floor with lag screws. Whether the floor is of cement or wood, before the bolts or screws are finally tightened, the machine should be leveled. This is very necessary in order to get the best skimming results. Separators are commonly leveled with a spirit level. It is placed across the bowl casing and the machine leveled from right to left and from front to back. It is important that all separators be leveled, but especially so with those not having self-balancing bowls.

A cream separator is usually the most delicate piece of machinery on the farm and it should be handled without undue roughness. Sudden jerks on the handle cause great strains on the bearings and reduce the life of the machine. In starting the separator, work up speed gradually and turn the handle so that there is an even pull all the way around. The too common practice of leaning on the handle as it goes down and giving it a jerk as it comes up strains the bearings and wears the gears unevenly. A watch or a pendulum which is furnished with some separators may be used to time the number of revolutions of the handle per minute.

A supply of good oil free from grit is essential to the separator if it is to run easily and wear long. The operator should see that there is a good supply of oil in the oil cup and make certain that the oil system is not clogged. With many separators the oil should be turned on when the machine is started and shut off when the separating is completed. Bearings and wearing surfaces should be kept free from dirt and grit. Perhaps the most necessary caution in the handling of a separator is not to tamper with it if it is running all right. The parts are finely adjusted and needless experimenting invites trouble.

Operating the separator.— Before the machine is started all containers for the cream and skim milk should be in readiness and a supply of hot water on hand. Also, the operator should make certain that the machine has been put together properly in compliance with the manufacturer's directions. When the machine has reached its required speed, the milk faucet may be turned on. In winter it is advisable to run hot water through the separator before the milk is started in order to warm up the bowl. If this is not done, the first milk which passes through will be chilled and the separation less complete, for the separator does the best work when the milk is at a minimum temperature of ninety degrees F.

As soon as the last of the milk is running out of the milk tank,

run through two or three quarts of hot water, or, if this is not available, use skim milk. Running through either the water or skim milk clears the bowl of all remaining cream. The use of water has the additional advantage of rinsing the bowl and other parts which come in contact with the milk, thereby making the subsequent washing easier.

Cleaning and sterilizing.—As soon as the separation is completed the separator should be taken apart and the bowl, together with all other tinware, rinsed with warm water. This should be followed by a thorough scrubbing with a stiff brush in hot water, to which has been added a washing powder, such as sal soda or one of the dairy cleaning powders. Following the washing process the utensils should be sterilized if a milk of low bacterial count is to be produced. Sterilizing may be done with the steam sterilizer described on page 323, or by boiling the utensils for five minutes.

The separator should be cleaned and sterilized after each time it is used.

MAKING BUTTER ON THE FARM

Good butter is not difficult to make provided the operator follows directions carefully. To produce good butter it is necessary to begin with a clean-flavored milk. It is customary in some sections of the country to churn the whole milk in making butter, but this requires high temperature in churning, which injures the quality of the butter and causes a loss of butter fat in the buttermilk.

The cream may be separated either by means of a centrifugal separator or by gravity. The former method is preferable, as less butter fat is lost in the skim milk and the separation is accomplished in a few minutes.

After the cream is separated it should be cooled in cold water to a temperature of fifty degrees F., if possible, and held there. Cream from later skimmings should be cooled before it is added to the cream which is already cold, as the addition of warm cream is liable to sour it.

Ripening the cream.—About twelve or eighteen hours before churning the cream should be slowly warmed to a temperature of sixty-five to seventy degrees F. (use thermometer) to obtain a uniform ripening. The cream should then stand at this temperature in a place free from odors. When it has acquired a clean, mildly sour taste and a glossy appearance it is ready for churning and should be cooled quickly and held at the churning

temperature for two hours. In summer from fifty to fifty-eight degrees F. is the most favorable churning temperature, and in winter from fifty-four degrees to sixty degrees F. Care should be taken to prevent the cream from becoming too sour; otherwise the butter will have a sour flavor and poor keeping qualities. Cooling may be accomplished by placing the can of cream in the cooling tank and stirring occasionally. Do not put ice or cold water into the cream.

How to churn.— Churning is the next operation. There are several types of churns which may be used with good results, but the barrel churn is probably the best suited to farm butter-making on a small scale. It is simple, easy to wash and operate, and is inexpensive.

When the cream is ready for churning, scalding water should be put into the churn and the churn turned over a few times. This will cleanse the churn and swell the pores of the wood if it has a wooden barrel. Scalding should be followed by rinsing with cold water. The butter workers, paddles, ladles, and printer should be given the same treatment and all but the worker placed in cold water.

The cream may now be poured through a coarse strainer into the churn. Straining is necessary to remove dirt particles and break up any lumps in the cream. The greatest concussion occurs if the churn is only one-third full. If too full it will take longer to churn. For best results the churning time should be from thirty to forty minutes. If butter comes in a shorter time it indicates that the churning temperature was too high. High temperatures and too rapid churning cause a loss of butter fat in the buttermilk, salvy butter, or a butter which contains too much buttermilk or too much water.

Coloring the butter.—A small quantity of butter color is generally added, except in the early spring or summer, when the butter has sufficient natural color. The amount of color required will vary from twenty to thirty-five drops per gallon of cream, according to the percentage of fat content.

When the color has been added the cover may be clamped on and the churn given a few turns. The churn is then turned bottom side up and the cork removed to allow the gas to escape. This should be repeated two or three times early in the churning. The churn should be turned at a speed that will give the greatest concussion or "thumping," which is ordinarily about sixty turns to the minute. After about twenty minutes of churning, small granules are formed and on the glass in the churn a thick mass

will appear which occasionally breaks away from the glass, leaving it clean. After this point the cream must be watched closely, and after every few revolutions of the churn the lid should be removed and the butter granules examined. When the granules are as large as wheat grains, or when they separate and rise to the top of the buttermilk, stop churning and draw the butter-

Fig. 173.—Working butter. Careful working is very important in making butter.

milk off through the hole in the bottom, straining it to catch any particles of butter.

Washing, salting, and working butter.—While the buttermilk is draining off, prepare the wash water. Clean water at the same temperature as the buttermilk (test with thermometer) and about double the quantity will be required. Pour half the water into the churn, clamp on the lid and give a few turns. The water is then drawn off through the strainer. The remainder of the water is then added and the butter washed again.

The butter worker should again be scalded and then rinsed

with cold water until cool, to prevent sticking. The butter should now be removed quickly from the churn with a ladle and paddle and placed on the worker. The hands should not touch the butter.

If weighing scales are available, weigh the butter before placing it on the worker. Butter salt or fine table salt is then sprinkled over the butter, allowing one ounce of salt for every pound of butter.

In working the butter, first press it with the lever into a flat mass about one inch thick. This mass is then folded over upon itself and again pressed out, not smeared or rubbed. This process, which distributes the salt and works out the moisture, should be repeated until the butter breaks when bent at an angle of forty-five degrees. Overworked butter has a salvy body and a greasy appearance. Underworked butter is generally brittle, gritty, with undissolved salt, and mottled in color. These undesirable qualities reduce the palatability and market value of the butter.

Butter packages.— Butter intended for home use is generally packed in glazed earthenware crocks. If intended for sale, it should be packed according to the requirements of the local market. Rectangular one-pound prints in cartons are generally preferred where butter is offered for sale, and such packages are sanitary and easily handled.

In making prints the butter is placed on a flat surface and the printer pressed down on it until completely filled. The surplus butter is then scraped off and the print pressed out on parchment paper for wrapping. After wrapping, the butter should be placed in a refrigerator. All utensils used in the buttermaking should be thoroughly washed with hot water, a dairy cleanser, and a stiff brush, then rinsed with hot water.

MAKING CHEESE ON THE FARM

American cheese.— In making cheese, trouble from the development of undesirable bacteria in the milk may be avoided by using milk freshly drawn from the cows. To remove the animal heat and odor from the milk, it should be run over an aerator or poured slowly from one container to another in a room where the air is pure. When this process has been completed, the milk is placed in a wash boiler or vat.

If a strong color is desired, add one teaspoonful of cheese color to every sixteen gallons of milk, first mixing the color in a dipper of milk before adding to the main supply. Next add

rennet extract to the milk. The rennet, which is added at the rate of one ounce to one hundred pounds of milk, is first mixed with a half-dipper of cold water and then poured into the milk. If rennet tablets are used, add one small tablet (about the size of a dime) to five gallons of milk, or one large tablet (the size of a quarter) to twenty-five gallons. The tablets are first dissolved in cold water and then added to the milk. These tablets can be obtained from a drug store or dairy-supply house.

The milk should be between the temperatures of eighty-six degrees and ninety degrees F. when the rennet is put in. Stir gently for two or three minutes after adding the rennet, and then let it stand until the curd is ready to cut. The milk should begin to curdle in ten or twelve minutes and should be tested frequently to ascertain whether the curd is ready for cutting. Testing is done by pushing the finger into the curd at an angle of forty-five degrees and then raising the finger. If the curd breaks clean across the finger, leaving no flakes, it is ready.

Cutting.—If possible use a regular cheese knife, one with a horizontal blade and one with a perpendicular blade, in cutting the curd. First cut the long way of the vat, then crosswise, until the curd is in one-half inch cubes.

Stir the curd gently for three minutes, heat to ninety-eight or one hundred degrees F., stirring while heating, and then hold for forty minutes. When the curd shows fine silk-like threads three-quarters of an inch to one inch long when rubbed on a clean hot iron the salt should be applied. Usually three ounces of salt for every ten pounds of curd is sufficient. Too much salt makes the cheese dry and retards curing, while too little salt may cause rapid ripening and "off" flavors. The salt should be thoroughly stirred through the curd and allowed to dissolve before the curd is put into the mold.

Molding.—The mold is filled by taking double handfuls of curd and pressing gently until the mold is full and well rounded. Any tin or wooden receptacle is satisfactory for molding, provided there are holes in it to let the whey out. The ordinary size of mold used is eight or ten inches in diameter and three inches thick. After the cheese has been in the mold a short time, remove, turn it upside down and replace it in the mold. After putting on the mold cover, the cheese is ready for the press.

Pressing.—A simple but efficient cheese press can be made out of an old wagon tongue. Nail a two-by-four on the wall about three feet from the floor. The cheese mold is then placed on a strong box a few feet from the wall and the wagon tongue rested

over the top of the cheese mold with the heavy end caught under the two-by-four. A weight consisting of a bucket full of stone is then hung over the free end of the wagon tongue to add pressure.

The cheese is then placed in the press, but only one-half of full pressure is applied. This is done by moving the weight to a point midway between the press and the end of the tongue. After a few hours the cheese is removed, placed in warm water for a few minutes, wiped dry, and rubbed smooth with the hand. A linen cloth six inches wide and long enough to go round the cheese is applied, and the edges of the cloth are folded down over the sides. Circular pieces of cloth are placed on the top and bottom, and the cheese is replaced in the mold and put under the press. Full pressure is applied for twenty hours.

Curing.—A good place to cure cheese is on a shelf in the cellar. The cheese should be turned and rubbed with the palm of the hand every day for a week or two; after that twice a week. It should also be wiped occasionally with a cloth and warm water. The temperature of the cellar should be from thirty-five to sixty-five degrees F. and the air fairly moist.

The cheese will be ready for market after two to four months of curing. The lighter it is salted, the sooner it will be ready; also, the more it is cooked, the slower it will ripen and the longer it will keep.

Cottage cheese.—To make cottage cheese, place the desired amount of skim milk in a pail or a "shotgun" can, warm to seventy-five degrees F. and allow it to stand at that temperature until curdled. A thermometer should always be used to determine the temperature. The temperature can be controlled by keeping the can of milk in a tub or sink, filled with water of the same temperature.

The time required for curdling will depend upon the freshness of the milk. When a starter or good sour milk is available, a better and more uniform cheese can be made and the time for curdling lessened. About a cupful of starter or good sour milk to the gallon of skim milk is sufficient. With that quantity of starter the skim milk will curdle in from ten to fifteen hours, while without a starter fresh milk may not curdle for twenty-four hours or longer. The greater the quantity of starter, the sooner curdling will take place. As soon as a firm, smooth curd has been formed it is ready for cutting.

Cutting, heating, and stirring.—The curd is cut into one-inch or two-inch squares with a knife. The temperature of the curdled milk is then raised to one hundred degrees F. and held for

half an hour, stirring gently from time to time. The degree of heating largely determines the dryness of the cheese; the higher the temperature, the drier the cheese.

Draining.—The curd is then poured into a cheesecloth sack or into a piece of draining cloth thrown over a pail. If a pail is used, pour out the whey occasionally so that draining will continue. In fifteen or twenty minutes the curd will become mushy and will drain more slowly. The sides of the cloth may then be raised and lowered every few minutes to hasten draining. When the curd is rather firm and the whey has nearly ceased to flow, it is ready for salting.

Salting.— Cheese may be salted to suit the taste. Usually from one to two teaspoonfuls to the gallon of milk is about the quantity desired. The salt may be sprinkled over the curd and worked in with a spoon or paddle.

Making cheese with rennet or pepsin.— Cottage cheese made with rennet, a junket tablet, or pepsin has a finer and more uniform texture and requires less time and attention in making. The time required for curdling should be from sixteen to eighteen hours. If curdling takes place sooner the cheese will be too dry and too firm. The process of making is the same as already described, except that the milk is warmed to eighty degrees F. and allowed to remain at that temperature for five or six hours, at which time two or three drops of liquid rennet per gallon of milk may be dissolved in a tablespoonful of cold water and stirred into the milk. If powdered rennet is not available, one-eighth of a junket tablet to a gallon of milk may be dissolved in a tablespoonful of cold water and stirred into the milk. Powdered pepsin may be used for the same purpose, a quantity that will remain upon the point of a penknife being dissolved in a tablespoonful of cold water and then mixed with the milk.

When rennet, a junket tablet, or pepsin is used, the coagulum is placed in a drain cloth without cutting or heating. A finer and heavier draining cloth is necessary because of the fineness of the curd. The cheese is salted as already described.

Pasteurization of the milk.—While for small-scale operation the pasteurization of skim milk may not always be practicable, it permits a better control of the fermentation, increases the yield of cheese, and renders the product safe from disease, producing organisms. With pasteurized milk it is absolutely necessary to use a starter.

Quality.— Sweet or sour cream added to cottage cheese makes a richer and more palatable product. If the cheese is to be kept

for several days it should be stored in a cold place and in an earthenware or glass vessel rather than in one of tin or wood.

THE BABCOCK TEST[1]

The Babcock test for fat in dairy products, named for its inventor, Dr. S. M. Babcock, chief chemist of the Wisconsin agricultural experiment station, is based upon the fact that strong sulphuric acid will dissolve the serum solids in milk and set the fat free from its emulsion. In conducting the test the charge is placed in a specially constructed test bottle and mixed with the proper quantity of sulphuric acid. The acid performs other functions than the simple solution of the serum solids. Much heat is developed by its action, and this causes the fat globules to lose their individuality and run together, a condition which greatly facilitates the separation from the serum. This separation is still further accelerated by the increase in specific gravity of the serum caused by the presence of the heavy sulphuric acid. When the solution of the serum solids is effected, the complete separation of the fat and serum is accomplished by whirling in a centrifuge. The fat is gradually driven into the graduated neck of the bottle and the percentage read directly.

Test bottles.—The Babcock test bottle for milk consists of a body holding about fifty cubic centimeters and the neck graduated so that the percentage of fat may be read directly. Seventeen and one-half cubic centimeters is used in the test, and this volume of average milk weighs almost exactly eighteen grams.

Milk pipette.—The charge for the Babcock test for milk is measured rather than weighed, the measuring instrument being a pipette graduated to deliver 17.5 cubic centimeters of milk. These pipettes, filled to their graduation mark, hold 17.6 cubic centimeters. The extra 0.1 cubic centimeter is allowed for the milk which clings to the walls. Pipettes may be obtained which conform to the requirements of the United States Bureau of Standards.

Acid measure.— For farm testing this may be a simple glass cylinder graduated to deliver 17.5 cubic centimeters.

The centrifugal machine.—This is commonly called the Babcock tester, and various types are on the market, ranging from the small, two-bottle hand tester to the large steam turbine or electric tester, accommodating twenty-four or more bottles. They all consist mainly of a horizontal revolving disk or wheel

[1] In preparing this material free use has been made of Bulletin A-12, U. S. Department of Agriculture, by Roscoe H. Shaw.

provided with swinging sockets to hold the bottles. At rest these sockets allow the bottles to stand upright, but when in motion, the centrifugal force causes the sockets to swing outward, bringing the bottles to a horizontal position, with the necks toward the center. Where steam pressure is available, a steam turbine tester is strongly recommended for the reason that it maintains a uniform motion under a definite pressure and at the same time the steam keeps the bottles warm and supplies the hot water required. Whatever kind of tester is used, it must be firmly secured to a rigid support. There must be no shaking or trembling of the tester when in motion.

Acid.— The acid used in the Babcock test is the commercial sulphuric acid, sometimes called oil of vitriol, and should have a specific gravity of between 1.82 and 1.83. It should be kept in glass bottles or jugs, preferably with glass stoppers.

Sulphuric acid is an extremely corrosive liquid, which attacks the skin, the clothing, wood, and most of the common metals. Should the acid be spilled on the clothing, it should be immediately washed off with plenty of water, and ammonia water applied; this in turn must also be washed off. Unless the acid is washed off immediately after contact with the skin, severe burns will result.

Testing strength of acid.— As already mentioned, the specific gravity of the sulphuric acid used should be between 1.82 and 1.83. It is much better to purchase it guaranteed of the proper strength than to bother with diluting the stronger acid. Creamery supply houses handle acid guaranteed to be of the proper strength, and if kept in well-stoppered containers it will not change.

DIRECTIONS FOR MAKING THE BABCOCK TEST WITH MILK

Measuring the charge.— In preparing the sample for the test, the milk is poured from one container to another two or three times. The tip of the pipette is immediately inserted and the milk sucked up with the mouth until it reaches a point well above the graduation mark on the stem; the dry forefinger is then quickly placed over the mouth of the pipette. By slightly relaxing the pressure of the finger the milk is allowed to flow down until it just reaches the mark. The tip of the pipette is now placed in the neck of the test bottle and the milk allowed to flow slowly down the side. If the bottle and pipette are held upright, the neck of the bottle may clog up and some of the milk run over the top. Care must be taken that none of the milk is lost during

the operation. When nearly all the milk has run out of the pipette, the last drop is forced out with a puff of the breath.

Adding the acid.— The temperature of the milk when the acid is added should be between sixty degrees and seventy degrees F., and the acid should be at about the same temperature. Seventeen and one-half cubic centimeters of the acid is measured out, and, with the bottle held at an angle, carefully poured down the side, the bottle being turned slowly at the same time so that any milk adhering to the neck will be washed down.

Mixing the acid and the milk.— The acid is now mixed with the milk by giving a combined rotary motion and gently shaking with the hand grasping the neck of the bottle, with the mouth of the bottle held away from the operator. When once commenced the mixing must not be interrupted until the solution is complete. The first effect of the acid on the milk is a curdling, which is subsequently dissolved. As the solution progresses the color changes first to a light yellow, then to dark yellow, then through various shades of violet to brown and finally to dark brown, if the acid is of the proper strength and the milk and acid are at the right temperature when united. Too strong or too warm acid produces a dense black. Common errors of beginners are failure to mix the acid thoroughly with the milk and to continue the shaking until the solution is complete. A good plan is to shake the bottle for a minute or so after the solution is apparently complete.

Centrifuging the bottles.— The bottles are now placed in the sockets of the centrifuge, taking care that they are equally distributed about the wheel or disk so that the equilibrium of the latter is not disturbed. An even number of bottles should always be whirled. Should an odd number of tests be made a test bottle filled with water may be used to balance the machine. When the bottles are in place, the tester is covered in order to keep the bottles from getting cold and to protect the operator from flying glass and acid should any of the bottles break. The tester is now set in motion and the bottles whirled four to five minutes at proper speed. This will be sufficient to bring practically all the fat to the surface. In cold weather, if a hand tester is used, it may be necessary to pour hot water into the jacket of the tester to keep the bottles warm.

Speed of centrifuge.—Farrington and Woll have calculated the proper speed of testers with wheels of different diameters to be as follows:

DIAMETER OF WHEEL IN INCHES	REVOLUTIONS OF WHEEL PER MINUTE
10	1,074
12	980
14	909
16	848
18	800
20	759
22	724
24	693

Adding the water.— Hot water is then added to the bottles until the contents come nearly to the lower part of the neck. The whirling is then repeated for two minutes. Hot water is again added until the fat reaches a point below the highest graduation mark on the neck. It must never reach the top mark, or some of the fat may be lost. This time the water should be dropped directly into the fat in order to clear the fat of the light, flocculent material which may be entangled in it and which would later interfere with the reading of the test. The whirling is repeated for another minute. The temperature at which the readings are taken is between one hundred and thirty degrees and one hundred and forty degrees F., and this should be borne in mind when the water is added, the object being to add the water at such a temperature that the temperature of the fat at the close of the last whirling will be between these two figures. The water used should preferably be soft water or condensed steam.

Reading the percentage.— Provided the test has been successfully conducted, the fat will be in a clear, yellowish liquid column sharply separated from the clear and nearly colorless acid solution immediately below it and with no foam on top. The bottles should be kept warm either in the tester or in warm water until read, and the readings should always be made at between one hundred and thirty degrees and one hundred and forty degrees F. The fat at this temperature, if other conditions have been correct, will have a well-defined meniscus at both the top and the bottom. The readings are made from the extreme bottom of the lower meniscus to the extreme top of the upper meniscus. An ordinary pair of dividers is useful in making this reading. The points are placed at the upper and lower limits, then lowered until one point is at the 0 mark; the other point will indicate on the scale at the correct percentage for the sample tested.

In some steam testers where the exhaust steam escapes into the jacket and no ventilation is provided, the temperature of the bottles will be too high. In such case, the bottles must be allowed to cool to one hundred and thirty to one hundred and forty degrees F. by placing them in water at that temperature for several minutes before making the reading.

Imperfect tests.—If the foregoing directions have been strictly followed, a perfect test should result. It is not to be expected, however, that the beginner will always meet with success. The next two paragraphs may be helpful in finding the trouble.

An imperfect test is caused by one of three things: (1) Foam on the fat column obscuring the upper meniscus; (2) a dark-colored fat column containing dark particles and with dark particles obscuring the lower meniscus; (3) a light-colored fat column containing white, curdy material obscuring the lower meniscus.

The first is caused by using hard water. Any one or a combination of the following may cause the second trouble: The acid was too strong; too much acid was used; the acid was too warm when added to the milk; the milk was too warm when the acid was added; the acid was dropped directly into the milk; the mixing of the acid and the milk was interrupted before the solution was complete; or the acid and milk were allowed to stand too long

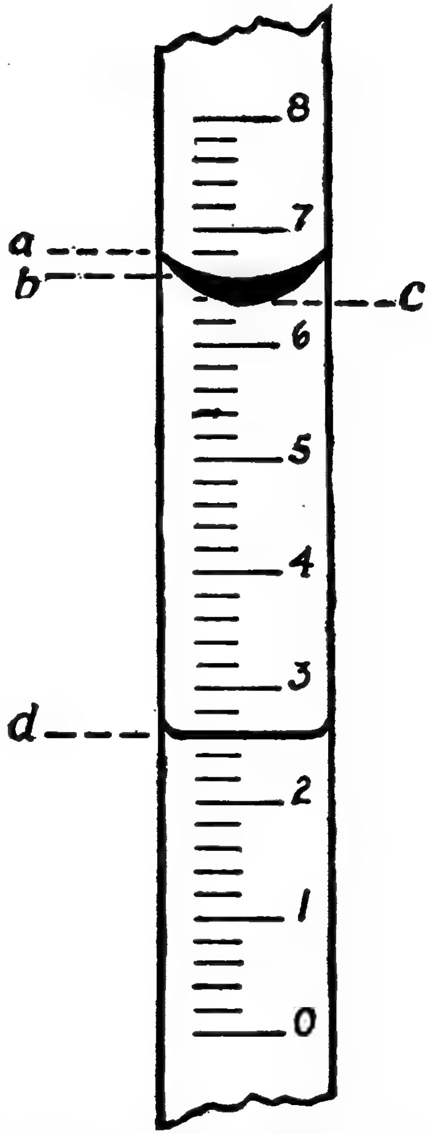

FIG. 174.—Method of reading Babcock test bottles. In reading fat column in milk testing, read from *d* to *a*, not *d* to *b*, nor *d* to *c*.

in the test bottle before being mixed. The third trouble is caused by one or more of the following: The acid was too weak; too little acid was used; the acid was too cold when added to the milk; the milk was too cold when the acid was added; or the mixing was not continued long enough to dissolve all the serum solids.

TESTING CREAM FOR FAT

Cream is tested by the Babcock test in much the same manner as milk, but there are some modifications that must be observed. The range of fat in cream, and consequently the specific gravity, is much greater than in milk, so that 17.5 cubic centimeters do not necessarily represent eighteen grams, as in the case of milk. Cream also varies in consistence, some being thin and some thick; therefore in some cases much more would adhere to the walls of the pipette than in others. For these reasons cream can not be accurately measured. The charge for the test must be weighed into the test bottle.

Cream-test bottles.— The cream-test bottles used in the Babcock test are of various designs. Those conforming to the requirements of the United States Bureau of Standards differ from milk bottles only in the graduations and in the length and diameter of the neck. Test bottles are made for both an eighteen-gram and a nine-gram charge.

Cream-test balances.— Several types of balances designed for weighing cream charges are on the market. The small torsion balances prove to be very satisfactory if care is taken that the important metal parts are not allowed to rust. Balances should be tested for sensitiveness from time to time and should always be kept in perfect condition.

Preparing cream for testing.— In testing cream or milk the small quantity taken for the test must be truly representative. No matter how carefully the test is carried out, if the charge taken does not accurately represent the cream or milk to be tested, the results will be worthless. The preparation of cream for testing does not differ materially from that of milk. The fat must be evenly distributed, and if there are no lumps this can be accomplished by pouring from one receptacle to another, warming the cream slightly, if cold. If lumps are present, it has been advised to pass the cream through a fine sieve, rubbing the lumps through with the fingers and then mixing as usual. If the cream has stood for some time in the sample jar, the top may have become hard, leathery, and difficult to remove. In this

case, the jars should be set in warm water until the contents have reached one hundred degrees to one hundred and ten degrees F., when the cream will be soft and can be easily removed.

Weighing the charge.—After the sample has become homogeneous throughout, the charge is quickly weighed into the test bottle. The weight of the charge depends upon the style of bottle used, but the nine-gram bottle is recommended. A pipette is useful in conveying the cream to the test bottle, as the flow can be easily controlled and checked on the drop when the pointer of the balance indicates that the correct quantity has been run in. This weight must be exact, and some experience is necessary before the charges can be quickly and accurately weighed.

Completing the test.—Instead of adding a measured quantity of sulphuric acid to the cream in the test bottle, as is done with milk, the best way is to add the acid until the mixture assumes the color of coffee to which cream has been added.[1] The quantity of acid required to produce this color varies with the percentage of fat in the cream. If the cream and acid, when mixed, are about seventy degrees F., about one-quarter or one-half of the regular quantity (four to eight cubic centimeters) of acid (specific gravity 1.82 to 1.83), depending

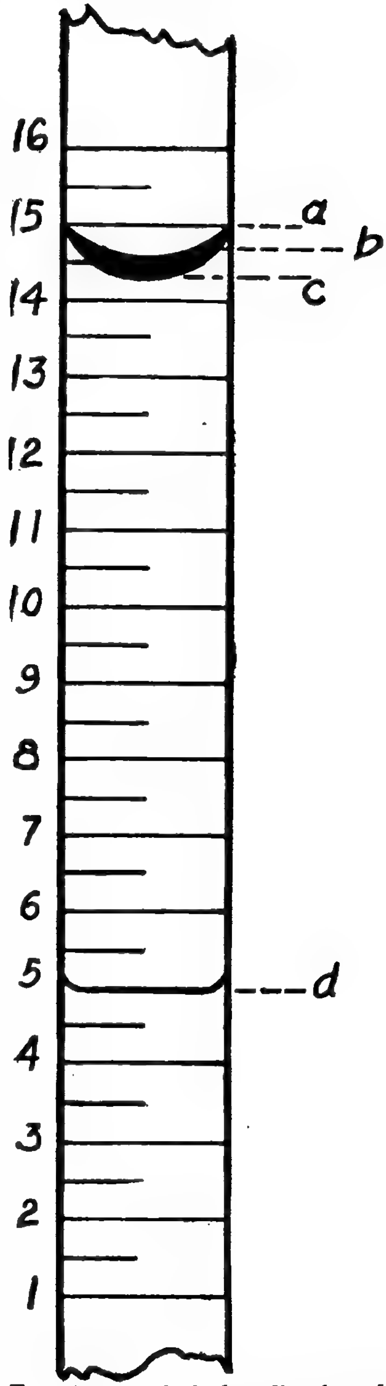

FIG. 175.—Method of reading fat column in cream test bottle. Read from *d* to *c*, not to *a* or *b*.

[1] O. F. Hunziker and H. C. Mills, Testing Cream for Butter Fat. Indiana Agricultural Experiment Station Bul. 145, June, 1910.

upon the percentage of fat, will be required for a nine-gram charge. After adding the acid to the cream, the procedure up to the reading of the percentage is exactly the same as in the milk test. After the final whirling, the test bottles are submerged to a point above the fat column in water at one hundred and thirty-five degrees to one hundred and forty degrees F. in a suitable tank. After remaining in the tank for about fifteen minutes they are removed and the readings quickly made. The important difference between reading the cream test and the milk test is that in the cream test the fat column included is from the bottom of the lower meniscus to the bottom, not the top, of the upper meniscus.

Some operators prefer to destroy the upper meniscus by dropping into the bottle at this point a few drops of a liquid in which the fat is not soluble. Glymol (petrolatum liquidum, U. S. P.), known commercially as white mineral oil, gives satisfactory results and may be purchased at almost any drug store. If the fat column is read with the upper meniscus intact, care must be taken that the eye is on a level with the points on the scale at which the readings are made; otherwise an error will be introduced.

TESTING SKIM MILK FOR FAT

In general skim milk is tested with the Babcock test in the same manner as whole milk, but the test does not apply to it with the same degree of accuracy. The reason for this is perhaps as follows: The fat in milk, as already shown, exists as fat globules of different sizes. In the process of skimming, either by the centrifugal separator or by gravity, the force tending to separate the fat from the other milk constituents acts more strongly upon the larger globules; consequently there is a much larger proportion of small globules in skim milk than in the whole milk. In the Babcock test the fat is driven into the neck of the test bottle by centrifugal force. Here again the force acts more strongly upon the larger globules. Some of the smaller globules never reach the neck of the test bottle. This is compensated for in testing whole milk by the liberal reading of the fat column, that is, by reading from the bottom of the lower meniscus to the top of the upper one. In skim milk, however, since most of the globules are small, a greater proportion of them fail to be driven into the neck of the test bottle; consequently the reading is too low and does not give the true

percentage of fat. The skim-milk test is valuable for testing the completeness of the skimming, but its results must not be interpreted too strictly.

The skim-milk test bottle differs from the whole-milk test bottle in having two necks, one of small bore graduated to read hundredths per cent for the fat column, and one extending nearly to the bottom of the bottle for filling.

Seventeen and one-half cubic centimeters of the skim milk are placed in the test bottle through the filling tube. Twenty cubic centimeters of sulphuric acid are added in two portions of ten cubic centimeters each, shaking after each addition. Great care must be taken, while shaking, to be sure that no particles reach the fat tube; otherwise it will become plugged and the test ruined. The test bottles are placed in the tester with the filling tubes toward the center. The first whirling is continued one or two minutes longer than when testing whole milk. As in whole-milk testing, hot water is added in two portions, the second one bringing the fat about half-way up the tube. The reading should be made immediately after the final whirling. If the fat is in

FIG. 176.—Modern barns and buildings on Davey Experimental Farm of the Federal Bureau of Animal Industry at Beltsville, Md.

the lower part of the tube it may be forced into the graduated part by the pressure of the finger at the mouth of the filling tube. Some skim-milk test bottles have the mouth of the fat tube enlarged to receive a rubber stopper which may be used to adjust the fat column for reading.

CHAPTER XVII

SHEEP

By Russell W. Duck, B.S.A., M.S.[1]

Types and breeds.— There are three principal classes of sheep, (1) fine-wool; (2) medium-wool; (3) long-wool.

Fine-wool breeds.— The fine-wool breeds are the American and Delaine Merinos and the Rambouillets. All fine-wools trace back to Spanish origin, where they were raised as early as the eighth century. This class of sheep is well adapted to large open tracts of land, as they flock well, and their dense wool is excellent protection against the elements. Fine-wool ewes are used some for early lamb production, as they can sometimes be mated in the spring. In general people living on small farms, who raise only a few sheep, have found it more profitable to raise either pure bred or grade mutton sheep instead of fine-wools.

The American Merino was produced principally in New England, by selection. The fineness of fiber, folds of skin and mutton qualities determine the class in which a merino belongs. Extremely wrinkled skin is always associated with very dense, fine fiber, and lack of mutton characteristics. Merinos of this class are called type A; they usually carry a large per cent of Spanish and American Merino blood. Those having folds over the neck and shoulder, smooth bodied with heavier fleshing and more open fleece are classed as type B; these also are largely of Spanish and American extraction. C type Merinos are practically free from folds in their skin; their wool is not so fine and dense, and they carry considerably more mutton; Rambouillets and Delaines are the breeds which make up this type.

Rambouillets, like all other fine-wools, trace back to Spanish origin. They were established as a breed in France during the latter part of the eighteenth century. They are larger in size than the other fine-wool breeds, carry more flesh, with less density and fineness of fleece.

The Delaine Merino was produced by selection from the American Merino in order to give a type showing more mutton and constitution.

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Medium-wool or mutton breeds.— There are eight principal medium-wool or mutton breeds, each one having certain characteristics and adaptations.

The Shropshire was originated in Shropshire and Stafford Counties, England, by crossing and selection with Morfs Common, Southdowns, Cotswolds and Leicesters. Shropshires or

FIG. 177.—Rambouillet ram, showing fine-wool type and character.

" Shrops " as they are commonly called are one of the most profitable and popular breeds in America to-day. They are well adapted to general farm conditions. Both rams and ewes are polled; the present type Shropshire is heavily wooled over the head and face, and well covered over the legs. Pure bred Shropshire rams are excellent to use in grade or scrub flocks, to build up the size, uniformity and lamb production.

The Hampshire was established by crossing and selection from Wiltshire Knots, Berkshire Knots, Southdowns and Cotswolds. Both pure bred and grade Hampshires are in big demand. The breed is polled, with black face and legs, and

rather large drooping ears. Their size is slightly larger than the Shropshire. Lambs of this breed are usually very dark when dropped, but, later turn white. Hampshires are well adapted to average farm conditions; they are hardy and good all-purpose sheep. For grading up a flock a pure bred ram of this breed is very desirable, as his black-faced lambs will always be in good market demand.

The Oxford was originated in Oxford County, England, by selection and crossing with the Cotswold, Hampshire and South-

Fig. 178.—Shropshire ram, showing mutton type and character.

down breeds. Oxfords are the largest of the medium-wool breeds, mature rams should weigh two hundred and seventy-five to three hundred and fifty pounds, mature ewes in good condition should weigh over two hundred pounds. The breed is polled. Pure bred rams are very desirable for use in grade flocks, especially where large size is desired.

The Southdown originated in Sussex County, England. The present type has been produced by selection from the old native Sussex sheep. The Southdown is a very old breed. They are the smallest of the common breeds of mutton sheep, and have a very superior carcass, being exceedingly firmly fleshed and evenly fattened. They have won more championships in carcass

classes than any of the other breeds, grades or cross-breds. Southdowns are very prepotent, and are a well fixed type. Pure bred rams of this breed if used on a grade flock will soon establish a very uniform and well fixed type.

The Dorset Horn is another English breed. They were originated by selection and crossing Old Dorsets and Somersets. Both rams and ewes have heavy spiral horns, those of the ram being much heavier and more twisted than the ewe; their face and legs are free from wool and covered with white hair; they are medium in size. This breed is especially noted for its ability to produce the so-called "hot-house" lambs, which are dropped in the early fall, and put on the Christmas market, in a highly finished condition. Ewes of this breed will take the ram any season of the year, and are more sure in this respect than either fine-wool or Tunis ewes. These three breeds are the only ones which will take the ram at any time other than the regular fall breeding season. Pure bred Dorset rams can be used to marked advantage in building up a grade flock where it is desired to raise lambs for this special kind of trade.

FIG. 179.—Pure bred yearling Tunis ewe.

The Cheviot was originated on the border of England and Scotland by selection and crossing the Old Cheviot, Lincolnshire and Leicester. The breed is hornless, the head, face and legs are free from wool, and covered with short, white hair. Cheviots do not flock together well, and for this reason are not well adapted to grazing on large open tracts of land; however, they are especially good rustlers, are exceedingly hardy, and will do well on small farms. Their fleece is of excellent quality. Pure bred rams of this breed can be used to good advantage in building up and improving grade flocks.

The Tunis originated in northern Africa. They show considerable variation in type; although considered hornless horns sometimes occur; the head, face and legs are free from wool, and covered with hair which varies in color from light yellowish brown to dark brown or mottled. The ears are large and drooping, and the tail is broad and fat; they are medium in size. This breed also excels in the production of early lambs, as they will mate in the spring and drop lambs that can be marketed in the winter when the demand is greatest. The rams are not so desirable for grading up a flock, as they are somewhat lacking in uniformity of type, with a corresponding variation in prepotency.

FIG. 180.—Pure bred Karakul ram. Yearling.

The Suffolk Down originated in England. The breed is polled. The head, face and legs are black; their fleece is rather light with a tendency to be kempy. Suffolks are not so popular as some of the other medium-wool breeds.

There are several other medium-wool breeds which are of little or no commercial importance in America. Among them might be mentioned the Welsh Mountain, the Ryeland, the Exmoor Horn and the Kerry Hill.

Long-wool breeds.— The three principal long-wool breeds in America are the Lincoln, the Leicester and Cotswold. The other and lesser known long-wool breeds of sheep are the Kent or Romney Marsh, the Black-Faced Highland and the Karakul. Long-wool sheep as the name implies have coarse, long wool, which usually hangs in long ringlets; however, as it does not contain much grease or yolk the average weight of a fleece from the three principal breeds is only about nine to fourteen pounds. Long-wools are very large sized. Mature rams in good condition should average over three hundred pounds. Their open fleece

makes it necessary to provide them with good shelter; they are not well adapted to large open tracts of land or extreme brush or hill country. Pure bred rams may be used in grade flocks where it is desired to increase size.

Lesser known breeds.— Corriedales have assumed some importance in the West of late years. They were originated by crossing Lincoln rams on C type Merino ewes, and are not yet well fixed in type.

The Karakul while classed in general as a long-wool breed is especially noted for the production of Persian lamb skins. There is a mistaken idea that these lamb skins are produced by Persian sheep, but such is not the case. The texture and quality of fur produced compares favorably with the finest fur on the market to-day. Other types of these fur-producing sheep are the Arabi, the Shiraz and the Duzbi.

The Shetland is a native of the Shetland Islands. They are very small, their fleece is used in the manufacture of hosiery and the famous Shetland shawls.

Other breeds of a wild or semi-wild type are the Rocky Mountain or Big Horn; the Barbados and the Barbary or Aoudad.

Market classification of sheep.— On the market sheep are classified according to the use to which they are to be placed. Their general appearance, condition and age largely determine into what sub-class and grade they will be placed. The market classes are (1) Mutton, or sheep which are intended for the block. Both native and western sheep are found in this class. (2) Feeders; these are largely westerns. (3) Breeding sheep; both natives and westerns are in this class. Natives show a predominance of medium-wool blood, while westerns show a predominance of fine-wool blood.

There are various sub-classes and grades for each class. Subclasses of mutton sheep are lambs, yearlings, ewes, wethers, bucks and stags. Feeders are subdivided into lambs, wethers, yearlings and ewes. Breeders are composed of ewes and rams. Age and condition determine almost entirely the grade into which any of the subclasses will fall. In almost all classes the grades range from prime to common, with a corresponding variation in price; present quotations (September, 1919), show an average for the five leading markets of $4.50 to $17.75.

Founding the flock.— It cannot be too strongly emphasized that there is no one best breed for all conditions and circumstances. Every breed has certain adaptations and characteristics which make it suitable for given conditions. The beginner

often debates between scrubs, grades or pure breds. No right thinking man expects or intends to keep on raising scrubs, and if he starts with grade ewes he must give some consideration to the predominant blood which they are carrying. If the future flockmaster has absolutely no knowledge of the care and management of sheep it is always advisable to start conservatively; the necessary experience will then not be so dearly bought.

For the average farm good grade ewes of mutton type headed by a pure bred ram, of any of the popular mutton-breeds will do very nicely for a beginning. Later a few pure bred ewes, of

FIG. 181.—Noting width of chest, and smoothness of shoulder.

the same breed as the ram, may be added. Age is an important factor in selecting breeders. Two years old is very acceptable for foundation material; by that time they are proven breeders, with the greater part of their usefulness still ahead of them. Both ewes and rams will begin to go down hill some after they have passed their fifth or sixth year; this is much more pronounced in the case of the ewes. Sheep get their first pair of permanent incisor teeth at one year; they get an additional pair of permanent incisors every succeeding year, until they have a total of four pairs of permanent incisors. There will always be

some variation in the above, however. At five years of age sheep will almost always have what is termed a "full mouth." Soundness, slope and color of the teeth are the relative guides for age after that. General form and bodily condition are also determining factors. Do not be afraid to buy a good ram. It pays.

Care and management.— Select a good breed or type, and do not change. Try to improve the breed or type you have selected rather than changing to another. Do not cross one breed on another, except in rare cases for commercial purposes. Keep

FIG. 182.—Taking depth of chest.

only the best. Ewe lambs that are one of twins or triplets are very liable to be prolific breeders.

Ewes should be bred as early in the fall as they will take the ram. Just prior to the breeding season ewes should be fed some grain in addition to pasture to put them in good physical condition, this is called "flushing." The ram should also be fed some good grain mixture at this time, preferably one relatively high in protein. By painting the under part of the ram's belly he will mark the ewes served; they should then be taken out and the date recorded, so the shepherd can tell approximately when they are due to lamb; later they should be tried back to the ram, thus making sure they are pregnant. The average period of

gestation for ewes is one hundred and forty-seven to one hundred and fifty-five days, or approximately five months. The birth weight of lambs taken from the average of all common breeds is six to nine pounds. The ram should be allowed with ewes only during the breeding season. A good ram properly managed can take care of from fifty to eighty ewes.

Dry, well-ventilated quarters must be provided through the winter. Pregnant ewes must be given plenty of nutritious feed

FIG. 183.—Beginning at top of shoulder and passing back with one hand, observe strength, straightness and fleshing of back.

or they cannot produce strong, healthy lambs. A very high, closely boarded fence built around the south side of the barn will keep out dogs, and give the ewes a nice place to sun themselves on bright days. During the lambing season the ewes should be visited two or three times nightly. A little extra care and attention at this time will be well rewarded. Each ewe should be kept separate with her lambs for at least twenty-four hours. Hinged hurdles can be used advantageously in making small temporary individual lambing pens.

Docking and castrating is not a difficult operation. When the lambs are four days to three weeks old is the best time for the

operation. The tail may be either cut, chopped or seared off with hot pincers. The hot pincer method has met with the greatest favor, especially in large flocks, as it practically eliminates bleeding, fly-blowing and infection. Castration should take place at the same time as docking. A good disinfectant should be liberally used. Five per cent lysol solution is excellent. The lower third of the scrotum should be cut off and the testicles drawn out, pull out any loose ends of cord that remain, disinfect

FIG. 184.—Taking width and length of loin, also thickness and firmness of flesh.

parts, and provide lambs with plenty of good. clean, dry straw to lie on. .

For marking sheep the following system of ear notching may be used:

Combinations can be easily arranged from this system which will give sufficient numbers in proper rotation suitable for any average sized flock. In pure bred flocks metal ear tags should be used.

Wool.— The time of shearing varies with different localities. In general it is best to shear as early in the spring as the weather

permits. If properly handled there is no danger in shearing pregnant ewes, however, with the exception that the South ewes should have yeaned before shearing time. Machine clippers are easier and more economical to use than hand shears. Remove all dirt and tag ends from the wool. Roll the fleece flesh side out, tie with hard-glazed or paper twine, and pack in large paper-lined sacks.

A general classification of wool is, Domestic, Territory and Carpet or Blanket. Subclasses are, Clothing, Delaine and Combing. The grade into which wool is placed depends on

FIG. 185.—Noting the degree to which the width of body is carried to the end.

several factors, such as density, condition, fineness, weight and color. Delaine and combing grades include, half-blood, three-eighths and quarter blood combing, common and braid. The commonly quoted grades of clothing wool are, half blood, three-eighths and quarter blood clothing. An average of ten representative sheep raising states for the month of August, 1919, show a range in price from forty-eight to seventy-three cents per pound for unwashed wool in the various grades. The percentage referred to is Merino blood. On the average the higher this percentage the nearer it approaches the top price.

Pasture, concentrates and roughages.— Sheep should not be

pastured with other kinds of live stock. Frequent change of pasture is advisable; shade and fresh drinking water should always be provided. An acre of good bluegrass will easily carry five mature sheep; an acre of rape will accommodate about seven. For the average farm about one sheep to every three acres of land is a good ratio; this will furnish enough land for frequent rotation of pasture. Continuous grazing on the same piece of land will cause sheep to become heavily infested with stomach worms. Weaned lambs should be provided with separate pasture. The following grasses make good sheep pasture:

FIG. 186.—Observing length of the rump by placing one hand at hip point, and the other at the tail end.

Bluegrass, Bermuda grass, orchard grass and native grass. Rough weedy land will often afford good pasture and benefit the land. Clover and alfalfa pasture are very liable to cause severe bloat unless sheep are accustomed to them. Rape is an annual forage crop affording sheep pasture par excellence.

The grain mixture fed should be thinly distributed over the bottom of the feed rack. It does not pay to grind feed for sheep. An old saying among experienced shepherds is that a sheep which cannot grind its own grain is not worth feeding. Pregnant ewes, if fed plenty of good nutritious roughage, will require very little if any grain; however, when sucking lambs

they should be fed from one-half to one pound of grain per head daily. Fattening sheep will require on the average from one to two pounds of grain mixture, in addition to one or two pounds of good clover or alfalfa hay and one to two pounds of corn silage (free from mold) per hundred pounds of live weight daily. The following are excellent grain mixtures for sheep:

Mixture No. 1		Mixture No. 2		Mixture No. 3	
Parts by weight		Parts by weight		Parts by weight	
Corn	6	Corn	5	Corn	4
Wheat bran	3	Oats	3	Linseed meal	1
Linseed meal	1	Wheat bran	2		
		Linseed meal	1		

Any of the above will give about the proper average nutritive ratio. Barley, emmer, kafir and milo may be successfully substituted for corn in any of the above. Wheat is not a profitable concentrate for sheep feeding.

Roughages for sheep include the various hays, ensilage and roots. The legumes such as clover, alfalfa and cow pea hay are all good. Timothy hay should not be fed to sheep as it is very

Fig. 187.—Grasping the leg of mutton with both hands well up, note thickness and firmness of flesh, and the depth and breadth of twist.

liable to cause severe constipation and impaction; this is especially true in the case of pregnant ewes. Corn silage can be safely and profitably fed, provided it is free from frost or mold. Roots such as mangels, sugar beets, turnips and rutabagas make excellent succulent roughage for sheep. Mangels or sugar beets should not be fed to rams or wethers, for very long, as they are liable to cause bladder stones; ewes, however, do not seem to be

FIG. 188.—Manner and place of opening fleece to examine the densest and finest quality of wool. Note also color and condition of skin. The same may be done on the hind quarter to examine the poorest quality of wool.

so troubled. Roots may be fed in conjunction with or successfully substituted for corn silage.

Marketing.—Pure bred sheep should be sold by private or public sale. Good pure breds should bring a much higher price than that quoted for market classes and grades. Sheep are usually shipped in double-deck cars. The average car will accommodate from one hundred to one hundred and fifty head per deck. The minimum freight rate on most roads is 16,000 pounds. A day or two before shipping only dry roughage should be fed. An average shrink in transit for sheep is four to eight per cent, depending on management and length of travel time. The average dressing per cent for fat sheep is fifty-three to fifty-eight per cent. When it becomes difficult for the lambs to

crawl through an eight-inch creep they are about ready for market. Spring lambs should be marketed from April to June, weighing from sixty to eighty pounds live weight.

DISEASES OF SHEEP

By Dr. J. H. Hewitt, D.V.M.

Cold in the head.—Caused by exposure to cold and dampness or draughts. Animal has nasal discharge accompanied often times by sneezing and coughing. Provide dry well-ventilated quarters and give one teaspoonful of sulphate of iron in the grain to two sheep.

Bloating.— See cows.

Diarrhœa.—See horse.

Constipation.— See horse.

Stomach worms are very frequently found in sheep and cause very great damage. They are small hairlike worms and are frequently overlooked on examination. If the animals become unthrifty in the spring with an occasional loss, look for worms. These can be kept from the flock by keeping tobacco dust and salt where the sheep can get to it. When affected give the following:

Powdered areca nut	four ounces
Powdered arsenous acid	one dram
Sulphate of iron	one-half ounce
Powdered nux vomica	two ounces
Powdered gentian	two ounces

This is one dose for twenty-five sheep. Repeat daily until results are obtained.

Scab is caused by a very small insect that burrows in the skin. It causes much irritation, uneasiness, loss of wool and flesh. Apply daily the following:

Lime water	eight ounces
Sulphur	six ounces
Creolin	two ounces
Cottonseed oil	eight ounces

or wash with the following:

Creolin	four ounces
Water	one pail

If many animals are to be treated use the lime and sulphur dip given in U. S. Bulletin.

CHAPTER XVIII

SWINE

BY PROF. JAMES R. DICE, M.S.[1]

The United States produces about half of the world's pork. The fat hog is an American product that will continue to have a place on our farms. Hogs will produce more meat from a hundred pounds of grain than any other farm animal. They will use many things from the farm that would otherwise spoil.

Successful practices in swine husbandry have recently undergone a remarkable change. There is a place for a sow and her litter on practically every farm in this country. The man that is not growing all of the pork that his conditions warrant is losing money. The man that is feeding hogs according to old methods is usually not making a profit. The hog has been, is and will be the mortgage lifter of the farm.

Types of swine.— There are two types of swine; the fat hog type and the bacon type.

The fat or American hogs should be low set, broad and long. Vigor and capacity are essential. Fat hogs are marketed when they weigh about two hundred and twenty-five pounds live weight.

The bacon hogs should be long and deep in proportion to their width. The sides should be straight from the front of the shoulder to the back of the ham. They are more active than fat hogs. Bacon hogs are marketed when they weigh about one hundred and eighty pounds live weight.

Breeds of swine.—

FAT HOG TYPE

1. Berkshire
2. Poland China
3. Chester white
4. Duroc Jersey
5. Cheshire
6. Victoria
7. Mule Foot
8. Essex
9. Small Yorkshire
10. Suffolk

BACON HOG TYPE

1. Large Yorkshire
2. Tamworth
3. Thin Rind or Hampshire

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Fat hogs.—

Berkshire.— Native of England. Color, black, with six white points, *i. e.*, white on tip of tail, nose or face and white feet. Ears erect.

The Berkshires are one of the most widely distributed breeds of hogs in this country, due to their adaptability and good dispositions. They excel in the quality of meat and are good

FIG. 189.—A fat barrow, low set, broad and long.

grazers, feeders and mothers. They are criticized for not maturing quickly and for not being prolific.

Poland China.— Native of Ohio. Color, black with six white points. Ears lopped.

The Poland Chinas are found principally in the corn belt. They excel in early maturity and rapid fattening. They lack in quality of meat, strength of bone, prolificacy and do not do so well in extremely warm or cold climates.

Chester White.— Originated in Pennsylvania. Color, white. Ears lopped.

The Chester Whites are popular in the East where a white breed is preferred. They are good feeders and produce large litters. They sunburn in hot climates and tend to be coarse and weak-boned.

Duroc Jersey.— Originated principally in the corn belt from New York and New Jersey stock by " men who had to make a living from pork growing." Color, red. Ears lopped.

FIG. 190.—A typical bacon hog, deep, long and narrow.

The Duroc Jerseys are popular pork producers, due to the fact that they are economical feeders, prolific and adaptable to varied conditions. A tendency to be coarse and rangy and to be wrinkled are criticisms which the Duroc Jersey breeders are endeavoring to meet.

Cheshire.— Originated in New York. Color, white. Ears erect.

The Cheshires as a breed are not widely distributed. The breed resembles the Berkshire somewhat in form and quality. The quality of the meat is good. They are good mothers.

Bacon hogs.—

Large Yorkshire.— Native of England. Color, white. Ears straight.

The Large Yorkshires are the most popular bacon hogs in this country. They are large in size, produce excellent bacon and

large litters of pigs. When crossed with fat hogs the result is a good general purpose hog. They have a tendency to have light loins and long legs.

Tamworth.— Native of England. Color, red. Ears large and straight.

The Tamworths are large in size. They tend to be more rangy and coarser than the Large Yorkshire. Otherwise, the two breeds are quite alike for bacon production. The Tamworths are especially hardy.

The Hampshires or Thin Rinds.— Native of England. Color, black with white belt back of shoulders. Ears straight.

The Hampshires are medium-sized. They are intermediate in type and sometimes classed as fat hogs. Quality and smoothness are characteristic. Usually only a part of the litters have the typical color markings.

Selection of breeding stock.— It is best not to select breeders until after they are six months old. Select the pigs before they are weaned if the selection must be made from young pigs.

Good individuals with plenty of vigor should be chosen, preferably from prolific dams.

The boars should be masculine, medium to large in size and rather compact. The sows should be feminine and rather rangy.

The boar pigs should be separated from the sows after they are six months old. The boars may be used for light service when they are eight months old. The sows may be bred when they are from eight to twelve months old.

The best time for sows to farrow for spring pigs is in March and April. For fall pigs in August and September. The gestation period for a sow is from one hundred and fourteen to one hundred and eighteen days, easy to remember as three months, three weeks and three days. When a sow is pregnant she is lazy. She should be compelled to exercise. Her feed should be bulky and abundant.

Management of sow and young pigs.— A week or so before farrowing time, the sow should be placed in a separate pen. The attendant should gain the confidence of the sow so that she will not be afraid. Fenders should be put around the sides of the pen. A two by six-inch plank eight inches from the floor is good. Short straw should be sparingly provided for a bed.

A sow will farrow twenty-four hours after the udder fills with milk. Other indications are the gathering of sticks or straw for a bed and uneasiness of the sow. A sow should never be moved or disturbed after she has made her bed or started to farrow.

Prompt assistance is necessary if the sow has difficulty in delivering the pigs. If the farrowing place is cold the pigs will need attention. A jug of hot water in a box is a good way to keep them warm. If a pig gets so cold that it is paralyzed, immerse in hot water and then rub dry and wrap in woolen cloth.

Exercise for sow and pigs at this time is necessary.

The sow should not be fed the day she farrows. Plenty of water should be provided. The sow should be on full feed by the third or fourth day and should then be fed liberally on a milk producing ration (see feeding).

Weaning: The pigs should not be weaned till they are at least six weeks old. Take the sow away from the pigs, not the pigs away from the sow if possible.

Castration of young pigs.— Pigs should be castrated when they are young. About a week before they are weaned is the best time. The longer the operation is delayed, the more of a setback it is to the pig.

The operation should be performed on a clear, dry day. It is best to let the pigs run in a clean pasture afterwards. It is well to play safe. The operator should wash the scrotum and also his hands and the knife in an antiseptic solution.

The attendant should hold the right hind and front leg of the pig in his right hand and the left hind and front leg in his left. In this manner the pig should be held in the lap of the attendant.

A testicle is seized between the thumb and forefinger of the operator and an incision is made over the most prominent part, parallel with the middle line of the scrotum and a half inch to the side of it. The cut should be long enough to free the testicle and should go through the sack that encloses the testicle. The membraneous sac is allowed to go back and should be cut loose at the inner part of the testicle so that the cords may be pulled out and scraped, not cut, off.

To castrate a pig is a simple operation and any farmer can easily perform it after a little practice.

FEEDS

Corn.— Corn as a hog feed is unequaled. It contains large amounts of carbohydrates and fats in a palatable form. More hogs are annually fattened on corn than on all other feeds combined. Corn is low in protein and ash content so that it should be supplemented with muscle and bone-building material.

Wheat.— Wheat is on a par with corn as a feed for hogs. The price of wheat usually makes it prohibitive for feeding purposes.

Barley.— Barley ranks next to corn and wheat as a fattening feed for hogs. Palatable protein feeds should be fed with barley.

Middlings.— Middlings are one of the popular feeds for pigs. They contain more protein and less carbohydrates than corn. They contain little bone-building material and should always be fed with corn, tankage, etc.

Tankage.— Tankage is a waste product of packing plants. It consists of meat scraps, fat trimmings and scrap bones thoroughly cooked, sterilized and ground. Tankage usually carries from forty to sixty per cent of digestible protein, together with considerable fat and ash. It is universally used as a supplement with corn and other carbohydrate feeds.

Milk.— Skim milk and buttermilk rank as the best supplements to use with fattening feeds. In addition to their protein content, they furnish growth accessories or vitamines which are necessary for normal growth. Both are profitably fed in the proportion of three pounds of milk to one pound of grain.

Garbage.— A limited amount of garbage can be fed with good results. Where garbage makes up the bulk of the feed, great care must be taken in feeding unless "garbage-bred" stock is used.

Forage crops.— Forage crops are indispensable for the proper feeding of swine. They furnish the necessary bulk and succulence to the ration. They also supplement the starchy feeds and supply the much-needed growth accessories. The legumes are especially good as they supply not only protein but also bone-building material. Various tests have demonstrated that the forage crops rank about as follows: Alfalfa, red clover, dwarf Essex rape, soy beans, and blue grass.

As a rule when feeding swine:

1 bushel corn fed alone returns 10 pounds gain.
1 bushel corn fed with pasture returns 14–17 pounds gain.
1 bushel corn fed with tankage returns 17 pounds gain.
1 bushel corn fed with skim milk returns 22 pounds gain.

Stock foods.— Experimental evidence obtained by several experiment stations has proven that the use of condimental stock foods with hogs, did not result in either larger or cheaper gains.

FEEDING

Self-feeders have entirely changed the method of feeding hogs. They should be used whenever practicable. They save labor and give better results than hand feeding.

The practice of "hogging down" corn and other crops has proven, without any question, to be an efficient method of gathering the crop and feeding the hogs. Tankage and feeds to supplement the crop are fed in self-feeders.

Rations for brood sows before and after farrowing.— Ear corn, 100 lbs.; digester tankage, 12 lbs.; wheat bran, 10 lbs.; oil meal, 4 lbs.; bone meal, 2 lbs. Or, shelled corn, 100 lbs.; alfalfa, 100 lbs.; tankage, 5 lbs.

Alfalfa should be fed in a rack. If the sows do not eat at least a half pound of alfalfa a day, it should be ground and fed with the corn; or corn and skim milk or buttermilk; or pasture, corn and tankage may be fed. Salt should be available at all times.

The following combination may be used: Corn, 100 lbs.; middlings, 100 lbs.; tankage, 20 lbs.

Rations for young pigs.— Red dog flour, 100 lbs.; crushed seed oats, 100 lbs.; tankage, 10 lbs. Soaked corn may be added.

Red dog flour, 100 lbs.; rolled oats, 100 lbs.; linseed meal, 100 lbs.

Corn meal or soaked corn, 100 lbs.; red dog flour or middlings, 50 lbs.; linseed meal, 25 lbs.; tankage, 10 lbs. Skim milk, 4 lbs. of milk for 1 lb. of grain may be substituted for tankage.

Rations for fattening hogs.— Hogs on fattening ration should have access to green feed, salt and sometimes limestone. Skim milk or buttermilk may be substituted for tankage in any ration.

Corn, 100 lbs.; red dog flour, 25 lbs.; tankage, 5 to 10 lbs.

Corn, 100 lbs.; barley, 100 lbs.; tankage, 10 to 15 lbs.

Alfalfa, pasture or hay, self-fed; shelled corn, self-fed; tankage, self-fed.

Rations for wintering breeding stock.— Alfalfa hay, in rack or ground; corn or barley, 100 lbs.; middlings, 50 lbs.; tankage (or milk), 5 to 10 lbs.

Recent experiments at the Iowa station have shown that when hogs are hand fed they should be fed three times a day. They should be fed such quantities as they will eat and clean up with relish. There is no advantage in grinding corn for swine. The most profitable way to feed corn to hogs is by the method which requires the least preparation unless a self-feeder is used.

NORMAL WEIGHT OF HOGS

According to Dietrich the normal weights for hogs are as follows:

WEIGHT	AGE	WEIGHT	AGE
50 pounds	2½ months	300 pounds	9 months
100 pounds	4 months	400 pounds	18 months
200 pounds	6 months		

Dimensions for hog crates.—

AGE OF HOG	SIZE OF CRATE
3 months	3′ x 12″ x 22″
6 months	3′10″ x 18″ x 26″
8 to 10 months	4′6″ x 20″ x 30″
Hogs	5′ x 24″ x 3′2″
800 lb. hogs	6′ x 30″ x 3′6″

Use 4″ x ½″ lumber.

THE SELF-FEEDER FOR HOGS

According to a government authority "A self-feeder is simply a device by means of which a supply of grain or other feed is kept constantly available to the hogs."

There are several types of self-feeders, both single and double. They may be built from three to six feet in length. Any agricultural college in the corn belt will supply plans for a good self-feeder. The type of feeder used by the Missouri Agricultural College is shown in the accompanying illustrations.

HOG HOUSES

Piggeries are of two types: the large centralized and the small movable.

Regardless of type, the requirements for a good house are: They should be clean and easily cleaned, dry, comfortable, well-lighted and ventilated, and be in connection with a good pasture.

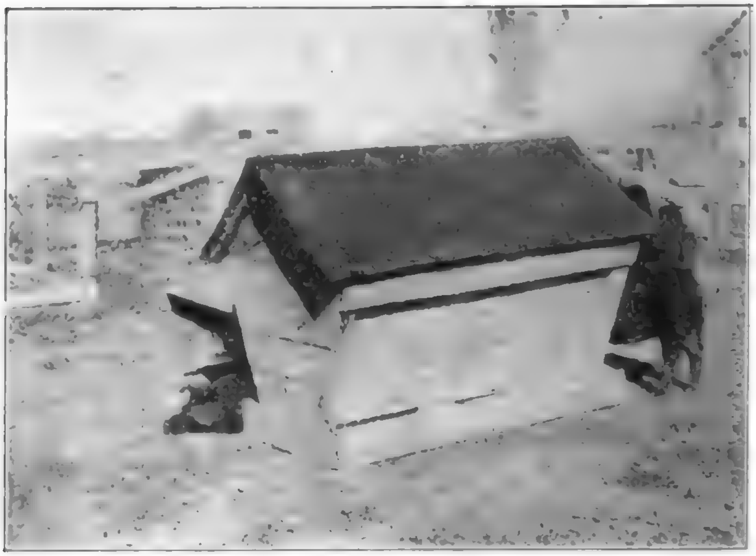
Small movable houses.— The small movable hog house is gaining in favor. It has the following advantages:

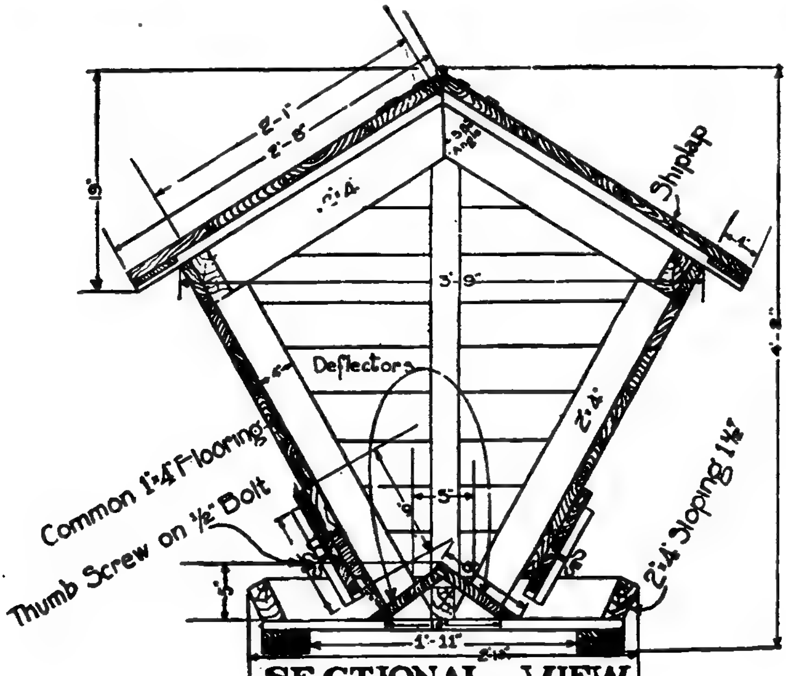
Ideal for use in changeable yards.

Easy to regulate exercise of hogs by placing house near or far from feeding place.

Easily moved to a new location.

They are warm as there is not a large space to heat. A barn lantern will serve as heater.





SECTIONAL VIEW

—Cross Section of a Two-way Feeder

FIGS. 191–192.—A two-way feeder used by the Missouri Agricultural College. Bulletin 144.

A

B

Fig. 193 A and B.—Movable houses used by the Iowa Station. Bulletin 152.

They are well-lighted and ventilated.

They are inexpensive.

A farmer can build his own hog houses.

The two most used movable houses are the A-shaped house and the gable-roof house.

There are several kinds of A-shaped houses. The Lovejoy house is probably the best for cold climates. The floor and each

FIG. 194.—Lovejoy house

side of this house are eight feet square. The lower two-thirds of the wall is lined with building paper and boards. The door and window in front serve for light and ventilation and allow easy access to the house. A swinging door may be used for cold weather.

For warm climates a single walled house is best with large doors hinged at the top so that they can be used for shade.

Large centralized house.— The advantages of the large centralized house, compared with the movable, are:

It is more convenient, as the feed, water and herd are all under one roof.

It is durable.

Lighting and ventilation may be more systematic.

It will serve as the center for all swine activities.

The disadvantages of a large piggery are that there is no chance to change the location to suit changing conditions. It is

difficult to get the hogs on new ground and considerable fencing is necessary to provide suitable range. The first cost is high.

The centralized hog house should be constructed so that the sun will reach all of the pens, especially in the spring at farrowing time. The half-monitor roof type of hog house has been a standard for many years. The Iowa Sunlit House has several advantages over any other community hog house.

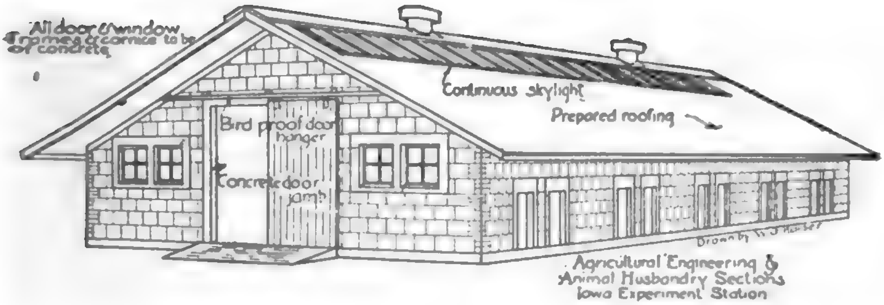


Fig. 195.—The Iowa sunlit house. Perspective drawing. Doors for the hogs are here arranged in pairs.—*Bulletin No. 166.*

BUTCHERING HOGS AND CURING PORK

It may not be practicable for every farmer to butcher and cure his own meat, but most farmers can do it profitably.

Best results are obtained when hogs not over two hundred pounds in weight are used. Do not feed the hogs for twenty-four hours before killing.

When sticking the hog make a small opening just in front of the breast-bone. The knife should be pointed directly toward the root of the tail and held in a line with the backbone. Push the knife in about six inches, edge toward the head. Do not twist or turn the knife. Avoid sticking the heart.

The old-fashioned scalding barrel and platform are efficient but laborious. A galvanized iron water trough is much better. The water should be at one hundred and fifty degrees for proper scalding. Use a thermometer. Some use a little lime, wood ashes or lye in the water. Keep the hog moving while it is in the water. When the hair and scurf slip easily from the surface, scalding is complete. The scraping should be done rapidly. Clean the head and feet first.

Insert a gambrel under all of the tendons, three or four inches below the hocks. After the hog is hung, clean with hot water and then with cold water.

Removing entrails.— Cut through the middle line, beginning

at the top and continue cutting down to the jaw. Split the hams to the pelvic (coupling) bone. If you have cut exactly in the middle it is possible to split the bone with the knife.

Place the knife between the first and second finger of the left hand, inserting the fingers where the opening has been made and with the right hand force the knife down to the breast bone. Insert the knife between the first ribs and split the breast by pulling up on the knife. In splitting the upper end of the breast bone be careful not to cut the stomach. Some prefer to split the breast bone from above.

Then remove the intestines and stomach, cutting the membranes that attach them. Cut down along the backbone and it will be easy to remove the pluck. Cut on each side of the tongue to loosen it and pull it out with an upward jerk. Put a piece of wood in the hog's mouth and wash out the inside of the carcass with cold water. Spread open the sides with a stick. To cool quickly, remove the head and split the carcass down the backbone.

The dressing percentage for good hogs is usually from seventy-five to eighty per cent; *i. e.,* twenty to twenty-five per cent offal.

Cutting up hogs.— Cut off the head an inch back of the ears. Cut off the shoulders between the fourth and fifth ribs and the hams two inches in front of the pelvic bones. Trim the hams and shoulders neatly. Remove the leaf lard by starting it in front and rolling it backward. Then take out the loin and spare-ribs. Cut the side lengthwise into three pieces. Use the upper strip for salt pork or lard and the two lower strips for bacon.

Curing meats.— A clean hard wood barrel or a crock are the most suitable vessels in which to cure meat. Meat should not be cured until it is thoroughly cooled, but it should be cured while it is fresh. Avoid freezing.

Plain salt pork.— Cut the meat into pieces about six inches square. Rub with salt and let stand over night. Then for every one hundred pounds of meat, dissolve nine or ten pounds of salt in four gallons of boiling water. When the brine is cold pour it over the meat.

Brine cured pork.— For every one hundred pounds of meat use seven to nine pounds of salt, two and one-half pounds of sugar (white or brown), sirup or molasses, one to two ounces of saltpeter, four gallons of water. It is safer to boil the brine before using. Bacon strips should remain in the brine four to six weeks; hams six to eight weeks.

Dry cured pork.— For each one hundred pounds of meat use:

Seven pounds of salt, two and one-half pounds of sugar, two ounces of saltpeter.

Four to eight pounds of salt, two to three pounds of sugar or warm sirup, one to two ounces saltpeter, three to six ounces black pepper, two ounces red pepper.

Apply the dry cure in three installments, four or five days apart. Rub it in well.

Sausage.— Sausage may be made as follows: Use only clean, fresh meat, three parts of lean meat to one part of fat. Beef may be added, if desired.

For every one hundred pounds of meat use: one and one-half to two pounds of salt, one to two ounces of fine sage, one-half to one ounce of ground nutmeg, four ounces of black pepper.

Use the above as a guide and season to taste.

DISEASES OF SWINE

By Dr. J. H. Hewitt, D.V.M.

Cold.— Caused by catching cold from exposure or being in damp quarters. Give one teaspoonful of the following three times daily:

Tincture of aconite	one-half ounce
F. E. belladonna	one-half ounce
Saltpeter	one ounce
Ammonium chloride	one ounce
Water to make	eight ounces

Snuffles.— Causes same as for cold. Put in dry, warm quarters and give treatment as for colds.

Constipation.— See horse.

Diarrhœa.— See horse.

Indigestion.— Caused from overfeeding or poor foods, exposure, chilling; animal loses appetite and appears to be in pain, shows more on movement. Give a large hog four ounces castor oil followed by one teaspoonful three times daily of the following:

Sodium sulphate	two ounces
Sodium bicarbonate	two ounces
Sulphur	one ounce
Salt	one ounce

Fits are generally caused from worms. Give the following for four days:

Castor oil	one tablespoonful
Turpentine	fifteen drops

This is for pig one month old.

Worms are very common in pigs, causing an unthriftiness and stopping the growth. Give hardwood ashes occasionally, also the following for a four-months-old pig daily for four days:

Castor oil	one-half ounce
Turpentine	one teaspoonful

Rheumatism, a very common disease in cold weather, due to cold and dampness combined. Provide dry, warm quarters with plenty of bedding; also give one-half teaspoonful of salicylate of soda in a little milk three times daily.

Hog cholera.—The most contagious disease of swine and the one that causes the greatest loss. It is caused by a germ that is readily spread from one to another or from one herd to another. This germ does not fly in the air, so must be carried in some way. Dogs, clothing, manure, sleighs and wagons, stone boats used in burying dead, are all common carriers. When the disease breaks out, separate the sick from the well and vaccinate the well. This latter operation will probably in most cases have to be done by a veterinarian, who will know the best methods to use. The symptoms are dullness, high fever, hiding under litter, red blotches showing on white skin, rapid breathing cough, high death rate. It is also known as "Swine Fever" and "Swine Plague."

WHAT TO DO IF CHOLERA EXISTS IN YOUR NEIGHBORHOOD

1. *CLEAN YOUR PENS. BURN ALL LITTER AND SPRAY REGULARLY WITH 1 PART OF COMPOUND CREOSOL SOLUTION TO 30 PARTS WATER.*
2. *CONFINE YOUR HOGS TO LIMITED QUARTERS, AWAY FROM STREAMS AND OTHER POSSIBLE EXPOSURE.*
3. *HOLD NEW STOCK AND STOCK RETURNING FROM SHOWS IN SEPARATE PENS FOR 15 DAYS AND DIP BEFORE RETURNING TO HERD.*
4. *DISINFECT YOUR SHOES, HORSES FEET, WAGONS AND OTHER EQUIPMENT BEFORE RETURNING FROM STOCK YARDS OR INFECTED FARM PREMISES.*
5. *KEEP PIGEONS, CROWS AND BUZZARDS AWAY FROM YOUR PREMISES.*
6. *TIE UP YOUR DOG.*
7. *BURN ALL ANIMALS THAT DIE ON YOUR FARM.*
8. *NOTIFY YOUR NEIGHBOR TO KEEP AWAY AND FOLLOW ABOVE PRECAUTIONS.*
9. *IF CHOLERA APPEARS IN YOUR HERD, CONTINUE ABOVE PRECAUTIONS AND TREAT WITH SERUM OR SERUM AND VIRUS.*

CHAPTER XIX

THE CURING OF MEATS ON THE FARM[1]

Keeping fresh meats.— Since certain parts of the animal carcass are more valuable in the fresh state than when preserved, it may be well to consider the various methods of keeping fresh meat before taking up methods of curing.

All meat to be preserved, either fresh or cured, should be thoroughly cooled after the animal is slaughtered, for unless this is done the meat will not cure well nor will it be possible to keep it in a fresh state for any length of time.

In cold weather, meat may be kept by hanging it in a dark, cool place, where dogs, cats, and rodents cannot reach it. If a temperature below forty degrees F. is maintained, meat may be kept for weeks; but with the temperature alternating between low and high, it will not keep well. Meat that is frozen will keep indefinitely so long as it remains frozen. Alternate freezing and thawing will spoil the flavor and cause early decomposition. It is important that the meat be kept in a place where the air is dry. A dark, cool cellar, or an attic that is dry and free from odors, is the proper place for keeping meat on the farm.

Meat packed in snow may be kept for a considerable length of time. The meat should first be frozen hard. After it is frozen, an earthen jar or a barrel should be provided, and a thick layer of snow should be tamped tightly in the bottom of this. On the snow a layer of meat is packed, and covered with another layer of snow. Care must be taken to have a thick layer of snow between the meat and the inner surface of the receptacle. Another layer of meat is then put on, and another layer of snow, and so on until all the meat is packed or the jar is almost full, when a heavy covering of snow should be put on top and covered with a block or some other object in order to keep out rats and mice. The meat may be taken out as needed, and the snow should be repacked on top each time.

Another method that is commonly used with pork and sausage is to partly cook the meat by frying it on both sides, pack it in a jar, and pour hot lard over it in order to seal the whole and keep out air. The meat may be taken out as needed. Care should be

[1] By permission of New York State College of Agriculture.

taken each time to melt the lard that is taken off, and to pour it back.

Curing meats.—As has already been stated, meat should be thoroughly cooled before it is cured. It is equally important, however, that the meat shall not be in a frozen condition, for if it is frozen the brine or pickling solution cannot penetrate freely and the meat will not be of even flavor throughout.

Vessels.—The vessels used for curing meats are of various sorts and sizes, depending on the amount of meat to be cured and the expense to which the owner cares to go.

Large earthen jars or crocks give the best results, but these are somewhat expensive — eight to ten cents per gallon of capacity — and they are very easily broken if not carefully handled.

Tight hardwood barrels may be used. New barrels or barrels that have contained molasses should be used, never vinegar or kerosene barrels unless they have been burned out on the inside. If molasses barrels are used they should be thoroughly scalded.

Chemicals used as preservatives.—The principal preservatives used are salt, sugar, and molasses, and their combinations. Chemicals forbidden by law and those known to have a bad effect on health should not be used.

Salt preserves meat through its astringent and slightly germicidal action. It hardens the muscle fibers and draws the moisture from the meat.

Sugar and molasses have an almost opposite effect. They cause the retention of the moisture of the meat, and keep the muscle fibers soft and tender. Therefore, salt and sugar are commonly used together, as the sugar gives a desirable flavor and prevents the hardening action of the salt.

Saltpeter is often used to retain the natural reddish color of the meat. It is detrimental to health and should be used sparingly if at all.

DIRECTIONS FOR CURING MEATS

Pork

Sugar-cured hams, bacons, and tongues

Method I.—After the meat has been thoroughly cooled, the carcass may be cut up and cured. Sugar-cured pork is preferable to dry-cured pork or plain salt pork because of its pleasant flavor and because the meat is not so dry and hard. Beef tongues may be cured in the same pickle with the pork. All the pork car-

cass may be cured except the loins, which are used fresh for chops and roasts, the spareribs, which are used fresh, and the trimmings, which are used for lard and sausage. The hams, shoulders, and bacons are sugar-cured, and the fat backs are dry-cured or pickled in a plain salt pickle.

Before the meat is placed in pickle or salt, all corners and ragged edges should be cut off and used for sausage and lard. If they are left on they will be wasted, for they will be thoroughly soaked by the pickle and will be of no use.

Rub the pork thoroughly with salt and pack it in a cool place over night. The next day pack it in a barrel or an earthen jar, with the heaviest hams and shoulders at the bottom, the lighter hams and shoulders next, and the bacons and tongues at the top.

For every one hundred pounds of meat weigh out ten pounds of salt, two and one-half pounds of brown sugar, and two ounces of saltpeter. Rub these together thoroughly, taking care that the saltpeter is finely powdered. Dissolve the whole by stirring it into four gallons of boiling water. Allow this brine to cool thoroughly, and then pour it over the meat. If it does not entirely cover the meat, add more water. The brine should cover the meat at all times. The meat may be weighted down with a block if necessary, for if it is not covered the projecting meat will decompose in a short time.

If the brine shows signs of fermenting during the curing process, it should be drawn off, boiled, and cooled, and then poured back on the meat.

The bacons and tongues may be taken from the pickle after four to six weeks, and after being washed in warm water they may be hung in the smokehouse and smoked. The lighter hams and shoulders will be ready to take out of the pickle in six to eight weeks, and the heavier ones at the end of the eighth week.

Method II.—Another recipe for sugar-cured hams, bacons, and tongues that has given good results is as follows:

Pack the thoroughly cooled meat in a cool, dry place, on a table that has previously been covered with a layer of salt. Sprinkle salt over each piece of meat, and add alternate layers of meat and layers of salt until all is packed.

Allow the meat to remain in the salt for eight to ten days, and then wash off the salt with lukewarm water. The meat is now ready to go into the pickle, which is mixed as follows: To eighteen gallons of water add five pounds of brown sugar, a small handful of saltpeter, and one tablespoonful of ginger. Stir the mixture until the solids are all dissolved, and then stir in twelve

pounds of salt. Stir until all the salt is dissolved. This amount can be increased or decreased according to the amount of meat to be pickled. Ordinarily one-fourth of this mixture will be enough for one hundred pounds of pork.

The pickle should test seventy-five degrees with the hydrometer test. If a hydrometer is not at hand, drop a fresh egg into the pickle; if the egg floats almost submerged, the brine is of the proper strength.

Pack the meat in a barrel or a jar, with hams and shoulders weighing over ten pounds on the bottom, those weighing less than ten pounds next, and the bacon strips and tongues on top. Pour the brine over the meat so that it is all covered, and weight it with a block so that none of the meat projects from the brine.

The bacons and tongues may be removed from the brine at the end of three weeks, the lighter hams and shoulders at the end of five weeks, and the heaviest ones after six to seven weeks. After the meat is removed from the brine, it should be washed in warm water in order to remove the crust of brine and any scum that may have formed, and after drying for an hour or more it may be hung in the smokehouse and smoked.

Brine salt pork.— Pack thoroughly cooled pork in a barrel or a jar after having rubbed each piece with salt. The following day weigh out for each one hundred pounds of meat ten pounds of salt and two ounces of saltpeter. Mix these, and dissolve the mixture in four gallons of boiling water. Allow this brine to cool thoroughly, and pour it over the meat in the barrel. Place a block on top in order to keep the meat submerged.

Fat backs are ordinarily used for salt pork cured in brine, but any part of the carcass may be cured in this way. The meat cures best when cut in strips or in six-inch squares.

The meat should be left in the brine and be taken out as needed.

Dry-cured pork.— To dry-cure meat involves more work than to brine-cure it, although it is a little less expensive in some cases. It is less difficult to merely salt the meat, pack in a jar, and pour the brine over it, than to rub the meat several times with the dry mixture. Also, the brine-cured meat is not so dry and is a little more palatable. Brine-cured meat can be kept anywhere as long as it is kept cool; dry-cured meat, on the other hands, should be kept in a cool, moist place, in order to insure even curing. With brine-cured meat there is no danger from rats and other vermin; but flies must be kept away from meat cured in either way.

In dry-curing pork, weigh out for every one hundred pounds of pork six pounds of salt two and one-half pounds of granulated sugar, and two ounces of saltpeter, and mix thoroughly. Divide the mixture into three portions. Rub one portion on the meat the first day, and pack the meat in a barrel. Leave it for three days. At the end of the three days take the meat out of the barrel, rub it with a second portion of the mixture, and repack it. Three days later rub the meat with the third and last portion of the mixture, and repack it. Let it stay in the barrel for ten to fourteen days. Then remove it, wash it in warm water, and smoke it.

Corned beef.—*Method I.*—Since corned beef is used for practically the same dishes as fresh beef, only wholesome, untainted meat should be used for this purpose. Naturally, the choicer the meat that is put into the pickle, the better will be the meat that comes out. The cheaper cuts of beef are ordinarily used for corning, because the choicer cuts are more palatable in a fresh condition. Plate, flank, shoulder, chuck, cross ribs, and rump are most commonly used for corning.

Frozen meat should not be put into the brine; neither should the brine be frozen while the meat is in it.

Weigh the meat. Cut it in pieces about six inches square. Place a layer of salt in the bottom of the vessel in which the meat is to be packed, cover this with a layer of meat, and sprinkle a layer of salt over the meat. Add alternate layers of meat and of salt until the meat is packed. Seven to nine pounds of salt will usually be enough for 100 pounds of meat. Allow the meat to stand in the salt over night. On the following morning make a brine, using five pounds of sugar, two and one-half ounces of baking soda, and three ounces of saltpeter for every 100 pounds of meat. Dissolve these ingredients in four gallons of boiling water. Allow the brine to cool thoroughly before pouring it over the meat. If more or less than 100 pounds of meat is to be cured, use these proportions for the brine. If four gallons of brine does not entirely cover one hundred pounds of meat, water may be added. The meat should be weighted down with a block or a clean stone, since any part that is not covered with the brine will decompose very quickly.

If the brine shows signs of fermentation in warm weather, it should be drawn off, boiled, strained through a clean cloth, and, after it is thoroughly cooled, poured back on the meat.

The meat should be kept in a cool, dark place. At the end of thirty days the meat will be ready for use. If the pieces are

larger than six inches square, a longer time may be allowed, according to the size of the pieces.

Method II.—The formula given under Method II (page 381) for sugar-cured hams and bacons may be used for corned beef also.

Smoking meats on the farm.—The smoking of cured meats aids in their preservation because the smoking process closes the pores of the meat or casings, and the creosote is objectionable to some insects.

Smoking gives a desirable flavor to the meat if the proper kind of fuel is used. Green hickory is best, but other hardwoods or corncobs may be used if hickory is not available. Resinous woods should never be used, as they give an objectionable flavor to the meat. Corncobs are commonly used, but are not so satisfactory as hickory because of the fine ash that is forced upward by the heat settles on the meat, giving it a dirty appearance. Juniper berries and fragrant woods are sometimes added to the fire, to give desired flavors.

Proprietary smoking preparations are not to be recommended, as a whole, because they hasten the curing process and do not give as desirable a flavor as does the ordinary smoking process. Some of these preparations also contain substances that cause digestive disorders when the meat is eaten. This is especially true of the various dips used to take the place of smoking.

The smokehouse.—The smokehouse may be of any size or construction to suit the needs of the owner. If the house is to be used only once and only a small amount of meat is to be smoked, a large barrel or a dry goods box may be used. If the house is to be permanent, it is often worth while to build it of brick, concrete, or stone, in order to avoid all risk of loss by fire. A frame house may be used, provided that care is taken to confine the fire to the center of the floor, or to build it in a large iron kettle, so that it will not spread to the house. The safest method of smoking meat, and at the same time of preventing the smokehouse from getting too hot, is to dig a small furnace pit in the ground about ten or twelve feet from the smokehouse, and have the smoke carried from this to the house through a galvanized pipe laid on top of the ground and covered so that it will not be crushed.

The method of construction of the smokehouse should allow ample ventilation, and there should be some means of regulating the draft. This can be done by having the outlet for the smoke

under the eaves and the intake for the air at the furnace, if this is used; or, if the furnace or outdoor fire method is not used, an adjustable air intake may be attached to the door and covered with a heavy screen to keep out flies and rats.

For ordinary farm use, the house should be about eight feet square and eight to ten feet high, so that the meat will hang six to seven feet above the fire and near enough to the roof to get the benefit of the thick smoke and yet be below the level of the ventilators.

The smoking process.— Meat that has been pickled should be removed from the brine at least a day before it is to be smoked, and after being washed in warm water it should be hung up to dry until it is ready to smoke. The meat should be hung in the smokehouse, with no two pieces touching each other, and then a fire should be started, heating the house gradually. The meat should be kept warm, but not hot enough to dry the outside too much and prevent the smoke from penetrating. There should be as much smoke as possible, but no more heat than is necessary.

In winter the fire should be kept burning constantly until the smoking is completed, for if the meat is allowed to cool too much the smoke will not penetrate it. Meat that has been frozen should not be put into the smokehouse until it is thawed.

In warm weather there is danger of getting the meat too hot, and for this reason it is good practice to let the fire die down every other day until the meat has become properly smoked.

After the meat has become properly colored, it should be cooled (but not allowed to freeze) by opening the ventilator on the door, leaving it open until the meat hardens. It may then be packed away for future use. If warm hams are piled one upon another before they are cooled sweating occurs where the two touch, and decomposition soon sets in.

The meat may be kept in the smokehouse for a time if the weather is not too warm, but the house should be kept free from flies.

If the smoked meat is to be used immediately, no further care is needed; but if it to be held until summer it should be wrapped in clean, white paper, and a covering of muslin sewed on to protect it from insects. It should be kept where it will not be subject to extreme change of temperature or to dampness.

If the meat is to be kept for a considerable length of time and absolute safe-keeping is desired, the following directions,

given by the United States Department of Agriculture in Farmers' Bulletin 183, page 37, should be followed:

"For absolute safe-keeping for an indefinite period of time, it is essential that the meat be thoroughly cured. After it is smoked and has become dry on the surface it should be wrapped in parchment paper; or old newspapers will do where parchment cannot be had. Then inclose in heavy muslin or canvas, and cover with yellow wash or ordinary lime whitewash, glue being added. Hang each piece out so that it does not come in contact with other pieces. Do not stack in piles.

"Receipt for yellow wash.— For one hundred pounds of hams or bacon take

3 pounds barytes (barium sulphate)
0.06 pound glue
0.08 pound chrome yellow (lead chromate)
0.40 pound flour.

"Half fill a pail with water and mix in the flour, dissolving all lumps thoroughly. Dissolve the chrome in a quart of water in a separate vessel and add the solution and the glue to the flour; bring the whole to a boil and add the barytes slowly, stirring constantly. Make the wash the day before it is required. Stir it frequently when using, and apply with a brush."

CHAPTER XX

BEES ON THE FARM

By E. F. Phillips, Ph.D.[1]

There are few animals on the farm more interesting than honey bees if their activities are watched. They are also profitable. Before undertaking to keep bees in connection with other

Fig. 196.—In the Canyon of Southern California beekeeping is profitable.

farming operations, it is well to look over the requirements of beekeeping to see whether this branch of agriculture will combine with the other work. Bees require considerable attention if they are to be made profitable, and this care must be given at the right time.

It is first necessary to learn from some local beekeeper or elsewhere just what plants are the most dependable as local

[1] Bee Expert, Washington, D. C.

sources of nectar. The bees will need care when these plants bloom and, having determined when this is, the next question is whether at that particular time other farm operations will occupy all the time of the person on whom the care of the bees will fall. If the bees will be neglected at swarming time because of other more pressing work, it will be better not to keep them.

Beekeeping is a branch of agriculture which requires a certain amount of specialization and it rarely pays to have a few colonies with a view merely to getting some honey for home use. Side line beekeeping was common years ago in some parts of the country and there were bees on almost every farm, but diseases of the brood of bees, now widespread in the United

FIG. 197.—A commercial apiary in Florida.

States, make this unprofitable. The bee owner who does not give bees the needed attention never gets a full crop but may get a little honey in years of plenty. In lean years his bees often starve, even though the good beekeepers of the region are getting a fair crop.

Location.— The bees should be protected from the prevailing winds of winter and be so placed that they will not disturb passers-by. They may be protected from the heat of the sun

in summer, but it is preferable that they get sunshine early in the morning.

Equipment.—It does not pay to keep bees in boxes or hollow logs ("gums"), nor in hives in which the frames are immovable. The ten-frame Langstroth hive is standard for America and by its use the beekeeper can help the bees to do their work better. All parts of the hives should be interchangeable and accurately cut. Additional equipment will depend on the kind of honey produced. For comb-honey there should be at least three shallow supers for each hive and more will usually be needed if the bees are properly kept. For extracted honey three full depth supers should be provided for each colony. A veil should cover the face when the bees are handled and a good smoker will subdue them. All necessary equipment can be obtained from the numerous dealers in supplies and every beekeeper should have a supply catalog. Unless one is an expert woodworker it does not pay to make hives at home.

FIG. 198.—Bee veil with silk-tulle front.

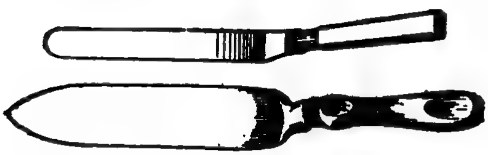


FIG. 199.—Knives for uncapping honey.

Behavior of the bees.—The most important part of the beekeeper's equipment is his knowledge of the bees. This can come only through study of the extensive literature on beekeeping, supplemented by observations on the bees themselves. It is impossible in the short space of this article to go deeply into this subject.

There are three kinds of bees in the colony: (1) The queen whose function it is to lay the eggs for the colony, sometimes as many as 3,500 a day, but who is in no sense the director of the colony activity; (2) the thousands of worker bees, sexually undeveloped females, which do the inside and outside work of the colony, and (3) the drones or males which mate with the

young queens, they being driven from the hive later. These bees all live together on combs composed of wax secreted by the workers and they are normally sheltered from wind and weather in some cavity, in the hands of man in a hive.

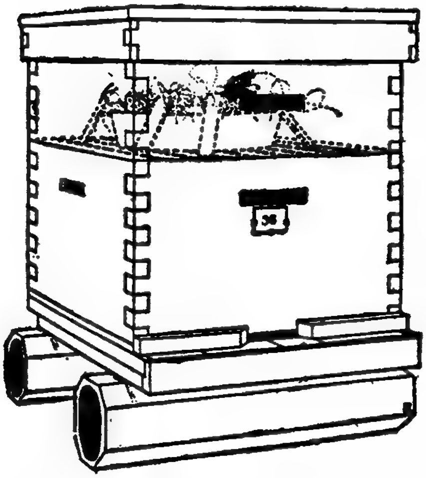


Fig. 200.—Pan in super arranged for feeding.

The population of the hive is constantly changing as the workers die rapidly from work and are replaced by bees newly emerging from the brood. The queen bees may live for several years, but the good beekeeper provides young queens every year or at most every two years. If the bees rear their own queens there is a loss in the honey crop at the times when the queens are old and cannot lay sufficient eggs.

Bees are creatures of instinct and their marvelous activities are not the products of intelligence. It is then most important that beekeepers know how these instincts operate in order to plan the environment so as to take full advantage of instincts which are advantageous. The storing of honey is a beneficial instinct while swarming is one which is not good from the standpoint of the beekeeper. Methods for taking advantage of the beneficial instincts are well worked out and are described at length in the books on the subject.

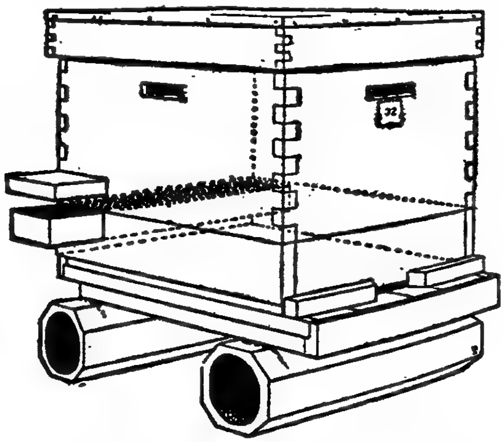


Fig. 201.—Feeder set in collar under hive body.

What the beekeeper does.—In directing these instincts, the beekeeper does two things: (1) He gives the bees such conditions that they breed up rapidly *before* the honey-flow, and (2)

he prevents the bees from dividing their gathering force by swarming before or during the honey flow.

To accomplish the first purpose, he protects the bees well during the winter wherever the temperature often falls to the freezing point, gives them an abundance of honey for this season and for early spring, and provides each colony with a good young queen. If the bees are not cramped for room in the spring they will then reach their maximum population in time even for an early honey-flow. Beekeepers who have a few colonies as a side-line rarely have full colonies soon enough, and even many specialist beekeepers fail in this regard. Wintering is the most important problem in beekeeping in most parts of the United States. It is fully discussed in bulletins of the Department of Agriculture.

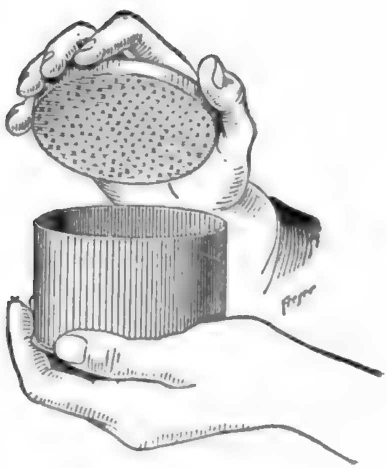


Fig. 202.—"Pepper-box" feeder for use on top of frames.

To prevent the bees from swarming involves more details than can be discussed here, but bees must have plenty of room in the brood-chamber, ventilation, adequate space for incoming honey and every other condition ideal for gathering. Directions will be found in the literature for making the most of a swarm if one should issue, but the beekeeper's ideal is to keep them even from making an effort in this direction.

The honey-flow.—With the care indicated the colonies will come to the beginning of the honey-flow with full strength. It is poor beekeeping to allow colonies to increase in strength at the expense of the crop. The next problem is to see that they have the proper space in which to store the honey. Most beekeepers with a few colonies now give each colony a single super, perhaps going back to put on another when the first is entirely filled. This may result in a loss of from half to three-fourths of the crop, for room must always be given before it is needed or the bees will decrease their gathering. As soon as they have begun to fill the first super, another should be placed underneath the first and this should be repeated as often as necessary. A good beekeeper often has four or five supers filled before the negligent beekeeper has the first one full. In comb-honey pro-

duction supers should not be added too fast or the bees will not fill the sections nicely. Obviously during the honey-flow the bees need care and unless they can receive it it is better not to have them. There is, however, little work on the farm which pays better for the time spent than does beekeeping. In years when there is little honey the bees require little attention, except to see that they do not starve, so that the beekeeper works when it pays him best.

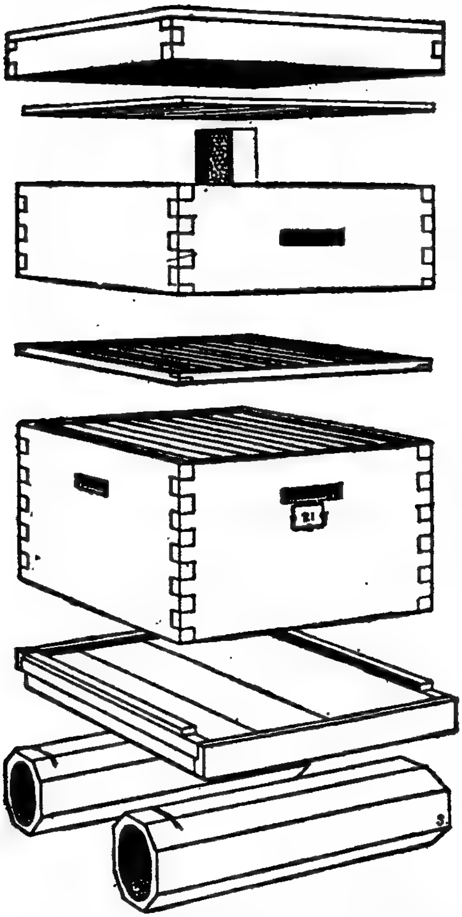


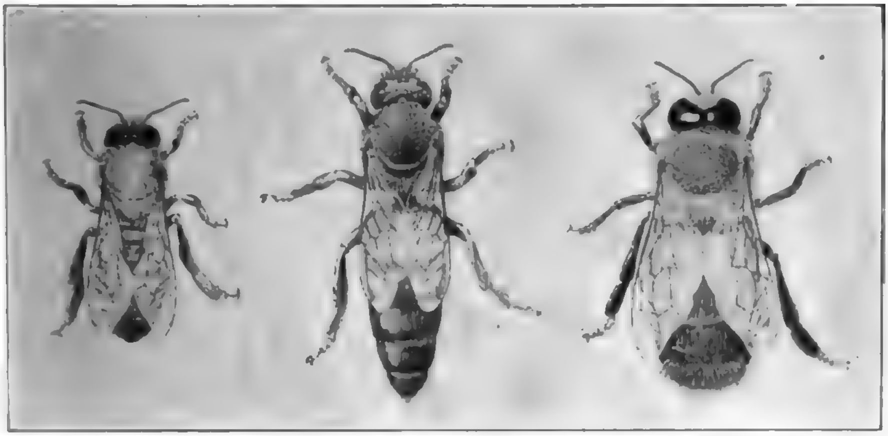
FIG. 203.—A ten-frame hive with comb-honey super and perforated zinc queen excluder.—*U. S. Dept. of Agriculture.*

Race of bees.—There are several races of bees, but there is none which surpasses the Italian. The common black or German bees are exceedingly poor and should not be tolerated in the apiary. Care is necessary in keeping the bees pure, for there are usually plenty of colonies of black bees in the woods or in poor apiaries and the young queens may mate with the inferior drones. By culling out the hybrid stock the beekeeper can keep his bees pure bred.

Diseases of bees.—Mention was made of two serious diseases of bees. Both are bacterial diseases which attack the developing brood and not adult bees. Hidden thus in the hive, they often escape the notice of the unobservant beekeeper. The beekeeper should constantly watch for any dead or discolored brood, and if any is found he should send a sample to the Department of Agriculture for examination. It is better, however, to know something about the diseases in advance. It is wise to make inquiry of thorough beekeepers in

the region or of the Department of Agriculture regarding the probable amount of disease in the neighborhood.

Value of bees to agriculture.— Beekeeping forms a branch of agriculture which adds to the food of the nation to the value of millions of dollars. The business is becoming a specialty and many are making it their chief work. The amount of sugar in nectar secreted by the multitude of plants on every hand far exceeds the entire amount of sugar of all kinds consumed by the American people. Honey production is the means of saving some of this vast store of sugar for human use. The raw material costs nothing, the work is well paid for by the returns and



A B C

FIG. 204.—A, worker; B, queen; C, drone.

there is every reason why bees should be increased and kept efficiently.

The honey produced is, however, not the main value of bees, for they add more to the wealth of the nation through their function as carriers of pollen from flower to flower. Cross-pollination is necessary in some species and varieties of plants, is desirable in others and is never detrimental. It is conservative to state that through cross-pollination the bees are several times as valuable as they are in gathering honey. Cross-pollination is brought about through the activities of many insects, but the honey bee is the only one which can be moved to the orchard or which can be propagated by man with profit. It therefore occupies a unique position, and as a result of this circumstance there are many orchardists who take up beekeeping, not for the honey

crop, but solely for the work of carrying pollen. Aside from the fact that they sting, bees have no bad habits which make them injurious. It has been claimed that they carry fireblight of the fruit trees, but it has been shown that other insects are the real culprits. They do not puncture ripe fruits but may suck the juices of overripe unmarketable fruit which has been punctured by birds or wasps. Bees are truly helpful insects.

CHAPTER XXI

THE FARMER'S WOOD LOT

BY R. P. PRITCHARD, M.F.[1]

Value.— On nearly every farm there is an area of greater or less extent that is not suited to the growing of farm crops. It is too rough, stony or steep, or the soil is too thin or too wet. This is the area on which the farmer should practice forestry. A permanent crop of forest trees should be kept on such an area, so that it may produce a definite annual yield or income. He is a very unprogressive farmer indeed who doubts the value of the farm wood lot.

It enhances the value of his farm and makes it more salable.

It is a reserve fund, and may furnish him with ready cash in time of need.

It is valuable for recreation purposes, and in some localities may furnish a steady income from this source alone.

It furnishes work in the winter months for the owner or for his men and teams.

It furnishes him with fire wood, posts, poles, and lumber at a very great saving over the market price.

The country to-day is dependent almost entirely on the wood lot for a good many valuable species like white oak, black walnut, black cherry.

A good farm wood lot may be regarded as money in the bank, and the amount of growth each year as interest on this capital. If you misuse the wood lot, or damage its growth, then you are spending more than your income and cutting into your capital. At the present time there is great need of building all over the country. The price of lumber is higher than ever before, and a good wood lot is greatly to be desired.

Protection.— If you have been neglecting your wood lot, start now and consider the following things every time you go into it, so that you may get the largest amount of interest possible on your capital invested.

Any trees of desirable species under twenty-five years of age? No? Then keep out the fires, keep out the stock, quit cutting out the best trees and plant some young desirable trees every time

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you take out the mature ones. That's the whole thing in a nutshell, and if you do this you will be safeguarding the future of your woodlot.

You can do a whole lot towards insuring yourself against fire by

1. Gathering up the débris and burning it during the wet season, or by gathering it into low piles with the stems on the ground so as to hasten its decay.

2. Plowing several furrows around the outside, so as to keep out grass fires.

As for grazing you must decide between your wood lot and

Fig. 205.—Typical woodlot conditions. Hardwoods in need of thinning, cleaning and planting.—*Photo by H. H. Tryon.*

your stock. If you must let them in then the future of your wood lot is destroyed. Keep them out and give it a chance.

Improvements.—The next time you make a cutting in your wood lot use the following scheme:

1. Do not cut a well-formed tree of a desirable species, unless it is absolutely the only one that will fill a special use. If you want a chicken for dinner you do not take the one that lays the most eggs. Use the same reasoning power in cutting your trees.

2. Cut the old, crooked, and misshapen trees first. They will serve many purposes equally well as the best.

3. Look for the undesirable species and cut them. They are the forest weeds. Red maple, gray birch, ironwood, dogwood come under this head.

4. Look for the trees that are beginning to rot. They will have shelf-like brackets or toadstools growing on the sides. These are the fruiting bodies of some fungous disease. They will produce millions of tiny spores, that will be blown around by the wind looking for wounds or openings in the bark of other trees. There is no practical way to fight these fungi in the wood lot except to keep the trees healthy, and the bark free from damage. The infected trees are enemies to the others. Cut them out.

5. Look for the trees that are infected with injurious insects. There are many kinds of forest-destroying insects that strip off the leaves, destroy the bark or wood. Individual trees of great value can be successfully protected against these insects by intensive methods. In general, however, it is best to cut the infested trees out to better protect the others.

6. Cut all dead trees and rotting stumps and branches. They are breeding places for both fungi and insects, and are enemies to your wood lot.

7. Distribute your cuttings over the whole wood lot or a part of it. Do not cut all in one place. It makes too big a hole in the canopy or "roof," and lets the soil dry out. This tends to keep out the natural reproduction of the species that you want. Cutting around the edge also lets in too much wind. Keep as dense growth as possible on the boundary of the wood lot.

8. If for some reason you must clear out your wood lot, or have cut too heavy in one place, plant it up with wild or nursery grown stock. If you do not, it will become waste land, or become restocked by worthless growth. Keep the best species there by planting when necessary.

9. Do not cut too heavy over the wood lot. It may cause loss by windfall, and too rapid drying of the soil. It means that you are taking out some of your capital, when it is desirable to take out only the interest. The amount that can be safely cut each year is the amount that is added by new growth. The forester, by means of growth and yield studies for a definite tract, can tell exactly what this amount should be. For the average wood lot it is probably between two cords and one cord per acre per year. You can start with that as a basis, and keep watch of the conditions of your stand. If you see that you are opening it up too much, do not cut quite as much next time. If you find that it is getting a little more dense, cut a little more.

10. Make each tree that you cut serve the purpose for which it is best suited. Convert it into the product that will bring the

best price. If a certain tree is suitable for railroad ties, or for fence posts, do not cut it into cordwood unless it brings a better price as such. If a tree is large and straight enough for saw-logs, see to it that it is made into saw-logs. This is simply the first principle of economy and conservation, and should be applied to the wood lot products, as well as any other product from the farm.

11. Use your head in felling the trees, keeping in mind the future value of the young growth. Drop them in the open places

FIG. 206.—Young white pine plantation. Trees marked for thinning.—*Photo by H. H. Tryon.*

as much as possible, or where they will destroy the fewest number of saplings.

12. Use a little thought, too, in planning your skidways. Have as few as possible and destroy only such young trees as is absolutely necessary. Do not drag your logs haphazard through the woods.

13. Cut your stumps low. It only takes a little more effort and may result in a great savings in board feet or cords.

14. Clean up the tops and brush. Do not leave it scattered about to increase the fire danger.

Follow out this scheme and watch your wood lot improve. Think what an advantage it would be to have an ideal wood lot that would furnish you a home-grown product for every use to which wood is put on the farm.

Reforestation.— Suppose your wood lot, like so many others, all through the East, has been neglected and abused, so that it is all worn out. No reproduction, no desirable trees. The thing to do is to plant. Suppose you have some waste land producing nothing. Plant it up to forest trees and make it do its share.

It is not practical to tell you here just what species to plant. Each farmer has more or less of a special problem, and he ought to get a forester's advice before he starts to plant. Here is the idea. He wants some species that will supply a local demand in a reasonable length of time. At the same time the species must be hardy in the climate; adapted to the situation; suited to the soil; and able to withstand insect and fungous attacks with which the region is infected.

As a rule a short time investment is the most profitable, and a rapidly growing species is needed. Perhaps there is a pulp mill near by, or a cheese box factory, or an excelsior mill. If so, Carolina poplar, which is a very rapid growing tree, can be grown at a profit.

If there is demand for box boards, white pine on a short rotation will fill the bill. An enormous amount of this species is grown on small areas in Massachusetts for this purpose. This tree has several dangerous enemies that may make it unwise to plant in certain localities.

If there is a willow basket and furniture factory in your neighborhood see if you cannot raise willows for them at a profit. Consider the local demand, and then pick a species that will fill it, and at the same time be suited to the region and the locality.

In New England and the Middle Atlantic States, the coniferous species most recommended for planting are the White pine, Red pine, Scotch pine, European larch, Norway spruce, and White cedar. Among the hardwoods the ones most used are the White ash, Yellow poplar, Sugar maple, Black cherry, Black walnut, Carolina poplar, Red oak, Sycamore, Basswood, Black locust, and Catalpa. The last two species are recommended for fence posts because of their rapid growth and durability. However, with the approved methods of timber preservation that we now have, durability may be sacrificed for rapidity of growth. Thus cottonwood even makes excellent fence posts when treated with creosote.

The method of field planting is simple. The soil is lifted with a mattock, the roots of the young tree placed in the opening, and the soil pressed back around the roots. It is very important that the roots of the seedlings should not be allowed to dry out.

When received if not planted immediately, the roots should be dipped in muddy water, placed in a shallow trench and covered with soil. In planting it is better for men to work in pairs. One man advances in a straight line, and digs the hole with the mattock. The other follows and plants the young trees in the openings. Two men should plant from one-half to one acre in a day.

The usual spacing of the trees is six feet apart in the rows, and the rows six feet apart. This gives 1,210 trees per acre. By cutting down this spacing to four feet by four feet, you double the number of trees per acre, getting about 2,500. If you have a good market for your product close by, and can go in and thin out your stand in a few years, and sell your thinnings at a profit then it is advisable to plant as closely as that. If you cannot thin your plantation in a few years, and want to wait a little longer for your forest conditions, then you can plant wider than six feet by six feet. Spacing the trees eight feet by eight feet, you have only six hundred and eight trees per acre. You will not have to thin, but your trees will suffer somewhat in height growth, and will not have as good clear length. A spacing of six feet by six feet seems to be the most desirable in most cases.

The best time for forest planting is in the spring as soon as possible after the frost is out of the ground. Trees may also be planted in the fall after the summer's growth has been completed, *i. e.,* from the last of August to the middle of October.

It is often practical to raise the young trees yourself, right on the farm. The seed is sown in seed-beds. The tiny trees are left in the seed-beds one to three years, then taken out and placed in transplant rows and left one or two years more. They are then ready to be planted in the field. They can also be purchased from your State Forestry Commission, or from local nurserymen. They will cost about four dollars per thousand, and you can figure the whole cost of making a plantation as about one cent per tree. That would make a plantation with spacing six by six, cost twelve dollars per acre; four by four, twenty-five dollars per acre; eight by eight, seven dollars per acre. In many cases it can be done more cheaply. You will find your State Forestry Commission eager to coöperate with you in every way if you have some land to plant with trees.

Marketing.— Maybe you have a large wood lot on which many trees are ready to be cut. No trouble to find a market. If you have only a small surplus over your own needs, get together with a few of your neighbors and get a salable amount. In the next

few years undoubtedly many wood lots will be cut by the portable sawmill. A practical, portable band sawmill has been devised, which is superior in efficiency, and grade of lumber produced than the old circular saw type. In the World War the American Forest Engineers were equipped with at least fifty of these mills. Uncle Sam is now selling them in this country to the highest bidder. The amount of building has decreased tremendously during the last two years, because of the war, and there is a great shortage of dwellings, and all kinds of buildings throughout the country. The price of all building materials has reached new

FIG. 207.—A forest properly logged under the Forest Service Regulations. The young growth is uninjured and the brush is piled ready for burning.

high marks, and contractors will surely turn to the wood lots for lumber for local building. If your wood lot is one of those to be cut, bear these things in mind, and do not let your land be stripped, without getting the most out of it, and arranging for its future productivity.

If your trees are ready for the market, look into the proposition and decide whether you want to undertake the cutting and hauling to the mill yourself, or whether you want to sell the timber on the stump. Perhaps you can do both the cutting and sawing yourself. You might be able to buy a portable sawmill or contract with one to do the sawing for you. Local conditions and markets will enable you to decide these things.

If you have a large amount of stumpage to sell, get a correct

idea of what it is worth, and do not sell too cheaply. A great many farmers have been induced to part with their timber at half its actual value, because they did not know any different. Don't be satisfied with the sawmill man's first offer. Get a forester, or a practical woodsman to make an estimate of it. Talk with someone who knows, and investigate the price of stumpage and lumber in your locality. Advertise it for sale to highest bidder.

The best way is to agree on a price per board foot, cord, or other unit, and have it all measured, and paid for as it is taken away. That is the way the United States Forest Service sells its timber, and by this method the purchaser gets just what he pays for — no more, and no less. Have the agreement in the form of a written contract stating the price, terms, method of cutting, and all the details. It will save misunderstanding.

Observe these elementary principles of forestry and make your wood lot a paying proposition and at the same time keep it for the next generation.

CHAPTER XXII

LOCATION AND ARRANGEMENT OF FARM BUILDINGS

By Dr. W. T. L. Taliaferro, D.Sc.[1]

In the location and arrangement of farm buildings, the primary considerations are sanitation, efficiency, economy, convenience and appearance. Each of these must be considered under several subheads, some distinct and some overlapping.

Under sanitation may be considered drainage, sunlight, fresh air, and ready and complete disposal of animal waste.

Under convenience may be considered distance and ease of access from home to buildings and from farm buildings to the fields and the highways, economy of time and labor in feeding and watering stock, and in handling crops and animal products.

Esthetic reasons suggest that the dwelling-house should front toward as extended and pleasing a view as may be obtained, with local ornamentation in the shape of a lawn with trees and shrubbery and flowers. In very many cases convenience dictates that it should front upon the public road and at no great distance from it.

Sometimes, and especially on large farms, it is more convenient to place the farm buildings in the center of the farm to avoid long distances from them to the outlying fields and consequent waste of time in going to and fro. As the farm dwelling-house should never be very far from the other buildings, in the latter case the dwelling must follow the other buildings. In any event, it is desirable that the site of the dwelling be on higher ground than the other buildings and capable of being made attractive.

A pleasing situation and attractive surroundings for the farm home not only gives constant pleasure to those who occupy it, but also adds appreciably to the market value of the property.

On the other hand, the drear, desolate "unhomy" appearance of some farm dwellings acts as a repellant on the would-be purchaser, while, at the same time, it kindles and daily stimulates a desire in the young people, especially, to leave the farm.

It is by no means necessary that the farm home be surrounded with large grounds and elaborate ornamental plantings. On the contrary, such surroundings are entirely out of place, for, gener-

[1] Maryland Agricultural College.

ally speaking, the presence of farm work would cause them to be neglected. A small yard bordered with flowering shrubs, covered with a smooth verdant sward and containing a few shade trees with one or two evergreens for protection against cold winds and to give a touch of verdure in winter, is appropriate, attractive and easily kept in order.

As every farmhouse should have a bathroom, so in its location consideration should always be had for the convenient and safe disposal of sewage.

When farmers make their homes so comfortable and attractive that they will wish to live their own lives in them, instead of moving to the country town as soon as they can afford it, the problem of how to keep the boys and girls on the farm will be well advanced towards solution.

The farm buildings should preferably be to the rear of the dwelling, though sometimes convenience requires that they be placed to the side.

The ideal location for the farm buildings would be to have them grouped about a yard open to the south, on well-drained, level, or slightly sloping ground; protected on the north and west, except in very warm climates, by higher ground, woods, or even a row of evergreen trees.

If possible the farm buildings should be located north or west of the dwelling also.

It is very difficult to keep a barnyard so clean that warm, moist winds blowing from it toward the residence will not carry with them unpleasant odors, unless the barnyard is at an inconvenient distance from the dwelling.

Good drainage of the ground under and adjacent to all farm buildings is a prime necessity, under no circumstance to be overlooked. If the location best suited from other reasons is not naturally dry, it must be made so by artificial means.

In the type of barn known as the bank barn, common throughout rolling or hilly sections, it not infrequently happens that the basement, being more or less in an excavation at the foot of a hill, is kept damp by seepage moisture which penetrates the walls and floors even though they are constructed of hydraulic cement. It is best to have no earth in contact with the basement walls, but, if that is thought desirable for the sake of warmth, then if the hillside tends to be at all springy, a tile drain with protected outlets should be laid at the bottom of the foundation wall, and a foot space between the wall and the earth bank should be filled in with fine gravel or coal ashes. In addition, all water from the

roofs should be collected in spouting and carried off from the building and from the barnyard. The barnyard itself should be level and slightly hollowed out in order to prevent the waste of the soluble part of the manure. In some cases with barns of this type, one sees the barnyard sloping down to and including a running stream, which furnishes an easy means of watering the stock, but also a disastrous source of loss of fertility. Especially should care be taken that no water from higher ground runs into or over the barnyard. Sunlight is the greatest of all natural disinfectants. Not only should the buildings be so arranged as to receive the greatest quantity of direct sunlight, but the yard adjoining should be flooded daily with sunshine. The noonday sun is the most beneficial, but, where location will not permit that, provision should be made to admit into all stock buildings the full morning sunshine. Domestic animals are early risers and they greatly appreciate the rays of the morning sun, especially in wintry weather.

Even in the hilly or rolling sections, many men are coming more and more to appreciate the disadvantages of the bank barn for cows, and are building light, airy, and well-ventilated cow barns with provisions for two rows of cows and ample windows to admit sunlight and air.

If such a barn be placed with its long axis running east and west, very little sunlight will reach the stalls of the north row. If the long axis runs from north to south, the sunlight will stream in through the east windows in the morning, while the west row of stalls will get the benefit of the afternoon sun.

In hog houses with a double row of pens, the accepted plan is to have the long axis run east and west with a "broken roof" to the south with two rows of windows, the upper row in the "break" and the lower in the south wall. These windows are so placed that the noon sun of winter will reach the back and the front pens through the upper and lower windows, respectively.

An abundance of pure water, easy of access, is indispensable for the well-being of the farmer's family and of his livestock. In hilly countries this may often be piped to the house and barn by gravity from a spring on the side of a hill, or be forced up by a hydraulic ram from one at lower altitude, and such an economical source of supplying this essential may well influence one in the location of his buildings.

In other situations, wind or gasoline furnish convenient lifting power. Where the spring is not too far from the other buildings, a stone or cement spring house furnishes cheap and effective

cold storage for milk, cream, butter and other products, but often the distance and the labor of going up and down hill make this arrangement onerous in the extreme and in the end costly. The milk house should be close to the barn and convenient to the dwelling, even if artificial cooling has to be resorted to. Sometimes when water is brought some distance in pipes, it becomes warm in summer before it reaches the milk house. If the water comes by natural flow, it may be chilled again before it reaches the house by letting it run through a coil in the bottom of a well.

Some writers insist that a dairy barn should be a one-story building. There seems to be no good reason, however, why it should not be built with a hay loft above, provided the loft be floored with matched stuff laid tight to prevent the passage of dust. For the further avoidance of dust, a barn of this sort should be so constructed that the hay will be brought down outside of the stable proper, or at least through a closed-in chute. At one end of the barn, provision should be made for a driveway close to the building and for convenient use of a hay fork.

No modern dairyman or stockman can be considered well prepared for the business unless his equipment includes one or more silos. These should preferably open outside the barn and into a closed and covered passage connecting the silo with the feed room. Ample space should be left about the silos for placing the cutter and power and for handling the wagons that bring in the corn or other material.

Similar provision should be made for the manure spreaders which receive and carry off the manure.

Hygienic laws require that cows and horses be kept entirely apart. On approved dairy farms, the horses are kept in a separate building. Horse barns also should be so placed as to admit of good lighting and ventilation.

Theoretically, manure should be hauled from the barn and spread every day. In practice this is very difficult, if not impossible. If the horse and the cow barns are so placed that when it is not possible to haul it daily, the manure from both classes of animals can be mixed. This will save much loss of ammonia from rapid fermentation or heating of the horse manure.

It is a matter of convenience and economy of time to have the building for the storage of farm implements, usually a long, deep shed, close to the horse barn and faced so as to protect the implements from driving rains and snows and also protect the men who may be busy with them in repairing, oiling, painting, etc.

Except in the extreme north, such open sheds faced to the south are better than closed barns for stock, cattle and sheep. If the windows are very cold and windy, the lower part of the front may be closed in. The important thing about such shelters is that they be so located that they will at all times be thoroughly dry.

A carpenter shop with a well-lighted bench and a blacksmith shop are extremely useful accessories on every farm of any size. These may be in the same building, which may be placed in any convenient situation somewhat in the background.

The farm flock is and will continue to be the principal source of poultry products. Since the farmer's wife usually looks after the flock and handles the proceeds, the farmer often gives but little thought to the poultry, and it suffers accordingly. No class of domestic livestock, however, responds more promptly and profitably to good attention than the farm hen, and she is worthy of the best that can be given her. Since the woman of the house has most to do with them, the poultry buildings must be where she can reach them easily and often. Neglected hens, sick hens, cold hens and hens with wet feet do not lay, and the health and comfort of the flock are often adversely affected by a bad location of their quarters. A southern or eastern exposure, a dry, and, if possible, sheltered situation convenient to shade in summer and, when the flock has to be kept up, to small lots for a rotation of poultry pasture crops, are indispensable where the flock is considered from a profit-making basis.

Each year sees more and more farmhouses equipped with running water and inside toilet facilities. But a very large proportion are yet and will continue to be dependent upon outside closets. Under sanitary management, it was necessary that these closets be placed at a distance from other buildings. But such distances are by no means necessary, and the situation of these buildings may be made much more convenient to those who have to use them if sanitary precautions are taken in the way of a proper receptacle for the waste, wire screens and an abundant use of dry earth kept ready to hand in the building, which must therefore be made large enough to contain a dry earth box capable of holding enough for a considerable period of time. Screened by a vine-covered trellis or low-growing evergreens, the proximity of such a building is not unsanitary and in no way objectionable.

Especially on farms where there is much outside labor

employed, there is need for toilet accommodations near the farm buildings and they should by no means be neglected.

The most modern of farm buildings is the garage. As that is unobjectionable in itself and easily capable of architectural adornment, it may be placed in any convenient situation outside of the danger limit. In its location, the chief requirements are as warm a place as possible, abundance of light and easy access from a firm roadway.

The location and grouping of the buildings are a separate problem on every farm, a problem to be solved only after careful consideration of the local conditions. An effort has been made here to call attention to some factors which may help in arriving at a proper solution.

CHAPTER XXIII

TREES, SHRUBS AND PLANTS FOR FARM AND HOME PLANTING[1]

The planting plan.— In the development of the home grounds there is need of a preconceived plan. This plan should be conceived in a general way, when the building sites are being selected, but the details may best be worked out after the buildings have been constructed and the drives and walks have been laid out. While the need for a plan is real, and its existence essential, there is no necessity of carrying it out all at once. The execution of the plan may be gradual; the most important parts of it may be developed first, and the remaining parts as circumstances permit. In fact, this gradual development is often desirable as the experience gained the first year or so often suggests desirable changes for future work. Under such conditions, a plan drawn to a definite scale, furnishing a definite record for future reference, is very essential as it insures the progressive development of the scheme that otherwise might be forgotten.

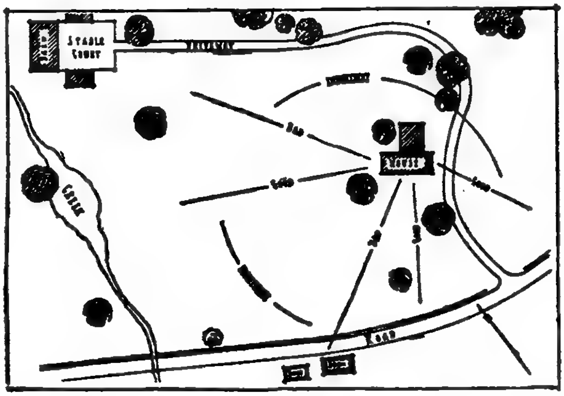

FIG. 208.—A farmstead with outlooks good, bad, and indifferent.—*Courtesy of College of Agriculture, Cornell.*

Planting.— Very ordinary looking buildings can be made attractive and homelike if the planting is properly done. It may be said that the less prominent the architectural features of a place, the greater the relative importance of the plantings. Hence it is very important that considerable attention be given to the planting of the ordinary farm house.

Functions of planting.— Before any successful attempt may be made in this line, one must first inquire as to the functions or

[1] By permission of C. P. Halligan, B.S., Mich. Exp. Sta.

purposes of the plantings to be made. In planting farm grounds, let it be realized that it is the endeavor to create a picture. That in this picture there are given as its elements a farm house and other buildings — roads, walks, lawns and other more or less separated elements. To unite these several disconnected parts into the production of one harmonious composition is the leading function of the plantings. To arrange the plantings about the house that the building may seem a natural outgrowth of the spot; to so arrange the plantings on the grounds that each and every planting may seem dependent upon the presence of every other planting or other element in the design, is the purpose of the planting.

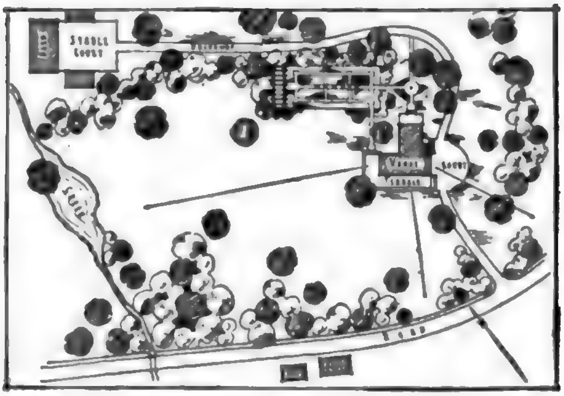

FIG. 209.—Diagram showing how the farmstead shown in Fig. 208 may be improved by plantings to accentuate the good outlooks and to hide the bad and indifferent ones.—*Courtesy of College of Agriculture, Cornell.*

When it can be realized that these plantings are made not primarily for the sake of their own individual beauty, but more because of their relationship to the design as a whole, to the picture about to be created, the first principle to guide one in planting has been mastered.

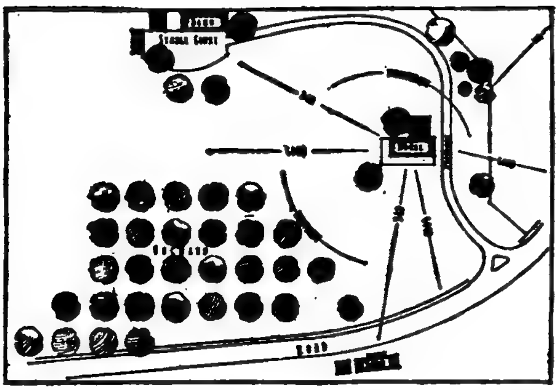

FIG. 210.—Diagram of farmstead with an orchard which acts as a screen from the road.—*Courtesy of College of Agriculture, Cornell.*

The planting of each and every grounds is a new problem, differing in certain respects from every other one. There are no definite rules then that can be given to guide one in the work; no ideal plan which may be drawn to serve all places; but there are a few general

principles which may be suggested as a guide when solving many of these problems. Before any planting design is made, the grounds should be studied in reference to the general arrangement that is most serviceable. The style of architecture of the house, the position and character of any large trees already on the grounds, the slope and general character of the land, and any other natural condition should be studied to "see what kinds of beauty, what general character of pleasing appearance these conditions most readily suggest." Each and every home grounds is more or less suggestive of a certain type of beauty which may be brought forth and emphasized with the least difficulty.

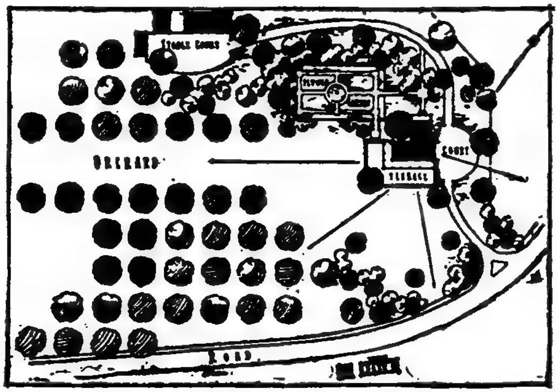

FIG. 211.—Suggested development of plan shown in Fig. 210, with good views accentuated and bad views hidden.—*Courtesy of College of Agriculture, Cornell.*

After perceiving this type of beauty, one must then proceed to make the necessary details of arrangement, emphasize and enhance the character thus selected. One will first find certain elements which detract from the beauty of the grounds, which are defects in the picture, and should be screened by the use of plantings. Views within the grounds such as the henhouse, barnyard, a boundary fence or service drive and other unsightly spots; views beyond the grounds as of a neighbor's shed, the back of a neighbor's barn and other views hardly pleasing and acceptable to the sight,—all these should be entirely hidden from view by the use of plantings, or at least partially broken up to minimize their unsightliness.

There are other elements in the design which should be just as carefully preserved and enhanced by plantings. The most pleasing lines and portions of the house, for example, may be emphasized and carefully preserved to the view. A wide sweep of open lawn, with a border and background of trees and shrubbery, is always a pleasing and acceptable sight. Vistas without the grounds as of a distant woods, a winding river or a neighboring farm house, and even the travel upon a public road, are often welcome sights which add to the pleasure and value of the

grounds. It is especially important that these vistas be carefully preserved from the living rooms of the house, not always from the parlor but from those rooms where the family spend the major portion of their time. The plantings then serve a very important function by concealing the defects in these places and by enhancing those parts that are most pleasing. Thus it may be seen how beautiful and attractive some of the ordinary looking farms of to-day may become by the proper use of plantings. How much more important this landscape use of plantings becomes on a common ordinary looking farm where there are generally so many unpleasant sights which detract from the looks and very often from the value of the farm.

Plantings, when improperly used, may detract from the value and looks of the farm as well. The effect of a well-designed farm house is very frequently ruined by poor plantings. Trees planted too thickly or too closely in front of the house; a lack of harmony in the design of the grounds to that of the house; plantings so placed as to hide the house from its most pleasing point of view — these are a few of the many causes which often spoil the effect of a well designed house by improper plantings. Let it be remembered then that plantings are to enhance rather than to detract from the expression already given by the design of the house and to harmonize it with its site.

There are three general rules of guidance in arranging the plantings:

1. Avoid straight lines in planting. The general effect of all lines in planting should be graceful and naturalistic rather than stiff, formal or artificial. Plantings should seem to be a natural outgrowth of the spot rather than a crude piece of man's handiwork.

2. Arrange the plants in groups and masses, selecting few kinds and many of each rather than many kinds and few of each.

Avoid planting meaningless, isolated specimens over the lawn. Naturalistic masses and groups of plants are necessary to give structural character to the design and each group or mass should consist of many specimens of but a few kinds rather than one or two specimens of several kinds. The kinds of shrubs selected should be repeated in the various groups and masses not precisely in the same combinations but sufficiently so that the effect of one planting may be harmonious with the others. In this manner unity of effect may be obtained.

3. Plantings should be massed about the base of the buildings, grouped about the junctions or curves in the walls, massed about

SHADE TREES.

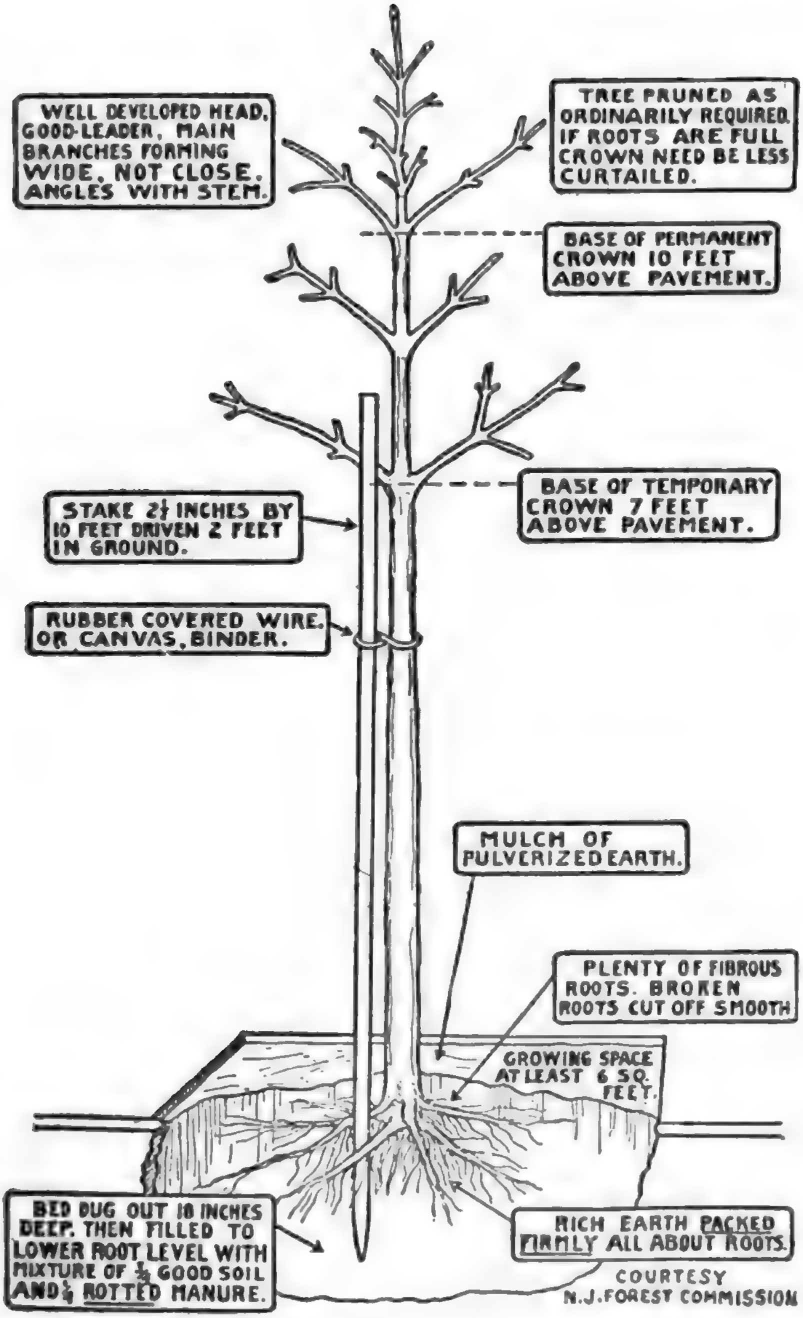

FIG. 212.—How to plant a tree.

the boundaries and corners of the property, but not usually along the front boundary of the property.

When arranged in this way, an open lawn bounded with naturalistic plantings of shrubbery and trees will be the general effect.

In arranging these plantings, they may perform other desirable functions also. They may be arranged to shelter the house from the winter storms and the summer heat, or to frame desirable vistas, and thus accentuate their attractiveness. Masses of shrubs may be used to take the place of an undesirable fence or hedge. They may be planted to prevent people from wearing paths across the lawns and to unify the walks, buildings and other elements of the grounds into one harmonious design.

How to plant.— The planting should be done early enough in the spring so that the shrubs will be well established before the heat and drought of summer overtakes them. In preparing the beds, they should be dug to a depth of a foot or more and well manured. The distance of setting them depends largely upon the size of their growth. Japanese barberries should be planted two feet apart, spireas three and one-half feet and lilacs about four to five feet. In three years, when set at these distances, the branches should be so intermingled that their individuality in the beds is lost, and a unified mass effect produced. In transplanting, keep the roots moist and prevent them from being exposed to the sun and wind any longer than necessary. Set the plants slightly deeper than they stood in the nursery, and pack the best fine soil firmly about the outspread roots. If the soil is dry, water after planting. It will help to compact the soil about the roots and keep them moist. The tops may then be pruned back to balance the loss of roots. leaving a few large buds on each of the strongest shoots.

TREES FOR SPECIAL PURPOSES

Street Planting

Acer saccharum
Sugar Maple
Acer platanoides
Norway Maple
Quercus rubra
Red Oak
Ulmus americana
American Elm
Quercus palustris
Pin Oak
Tilia vulgaris
Linden

Specimen Planting

Acer platanoides Schwedleri
Purple Norway Maple
Magnolia soulangeana
Soulange's Magnolia
Cratægus coccinea
Scarlet Thorn
Cladrastis lutea
Yellow-Wood
Cornus florida
Flowering Dogwood
Quercus (*In Variety*)
Oak
Populus nigra italica
Lombardy Poplar
Sorbus americana
Mountain Ash
Pyrus (*In Variety*)
Flowering Crabapple
Cercis canadensis
Redbud or Judas Tree
Betula (*In Variety*)
Birch
Prunus cerasifera Pissardii
Purple-leaved Plum
Morus alba pendula
Tea's Weeping Mulberry
Thuja (*In Variety*)
White Cedar
Picea (*In Variety*)
Spruce
Fagus (*In Variety*)
Beech

Exposed Lake Front

Caragana arborescens
Siberian Pea Tree
Betula pendula
European White Birch
Elæagnus angustifolia
Russian Olive
Pyrus baccata
Flowering Crab
Robinia pseudacacia
Black Locust
Pinus nitra austriaca
Austrian Pine
Pinus sylvestris
Scotch Pine
Picea canadensis
White Spruce
Picea excelsa
Norway Spruce
Betula populifolia
American White Birch
Cratægus oxyacantha
May Thorn
Cratægus oxyacantha coccinea
Scarlet Thorn
Populus Eugenei
Carolina Poplar
Junipersus communis hibernica
Irish Juniper
Pinus montana Mughus
Dwarf Pine
Sorbus americana
Mountain Ash
Quercus macrocarpa
Mossy Cup Oak

Windbreaks

Pinus strobus
White Pine
Picea excelsa
Norway Spruce
Pinus resinosa
Red or Norway Pine
Pinus sylvestris
Scotch Pine
Thuja occidentalis
White Cedar or Arbor-Vitae

SHRUBS FOR SPECIAL PURPOSES

Hedges

Berberis Thunbergii*
Thunberg's Barberry
Rosa rugosa
Japanese Rose
Spiræa Vanhouttei
Van Houtt's Spirea or Bridal Wreath
Deutzia Lemoinei
Lemoin's deutzia
Ligustrum amurense
Amur Privet
Lonicera tartarica
Tartarian Honeysuckle
Thuja occidentalis
Arbor-Vitae or White Cedar

Border Planting

a. Low Growing

Deutzia gracilis
Slender Deutzia
Berberis Thunbergii
Thunberg's Barberry
Symphoricarpos orbiculatus
Coral Berry or *Indian Currant*
Kerria Japonica
Globe Flower or *Corchorus*
Spiræa Bumalda var. Anthony Waterer
Anthony Waterer's Spirea
Spiræa Thunbergii
Thunberg's Spirea
Symphoricarpos albus
Snow Berry

b. Medium Growing

Ribes ordoratum
Yellow Flowering Currant
Spiræa Vanhouttei
Van Houtt's Spirea or *Bridal Wreath*
Spiræa prunifolia
Plum-leaved Spirea
Rosa rugosa
Japanese Rose
Rhodotypos kerrioides
White Kerria
Deutzia Lemoinei
Lemoin's Deutzia

c. Tall Growing

Diervilla florida
Rose-colored Weigela
Lonicera Morrowii
Bush Honeysuckle
Forsythia intermedia
Golden Bell
Viburnum (*In Variety*)
Philadelphus coronarius
Mock Orange or Syringa
Lonicera tartarica
Tartarian Honeysuckle
Syringa (*In Variety*)
Lilac
Euonymus americana
Strawberry Bush

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* The plant names in this bulletin are those adopted by the American Joint Committee on Horticultural Nomenclature.

Specimen Use

Corinus americanus
Smoke Tree
Euopymus alata
Winged Burning Bush
Chionanthus virginica
White Fringe
Exochorda racemosa
Pearl Bush
Prunus cerasifera Pissardii
Purple-leaved Plum
Prunus communis
Flowering Almond
Caragana arborescens
Siberian Pea Tree
Tamarix (*In Variety*)
Tamarisk
Cercis canadensis
Red-bud
Chaenomeles japonica
Japan Quince

Exposed Lake Front

Rosa setigera
Michigan Prairie Rose
Viburnum opulus
High-Bush Cranberry
Tamarix
(*In Variety*)
Rhus (*In Variety*)
Sumac
Rhamnus cathartica
Buckthorn
Elæagnus argentea
Silver Thorn
Rosa rugosa
Japanese Rose
Syringa vulgaris
Lilac
Philadelphus coronarius
Mock Orange

Shady Situations

Symphoricarpos albus
Snow Berry
Symphoricarpos orbiculatus
Coral Berry
Calycanthus floridus
Sweet-scented Shrub
Cornus (*In Variety*)
Dogwood
Diervilla hybrida var. Eva Rathke
Weigela Eva Rathke
Viburnum (*In Variety*)
Ligustrum amurense
Amur Privet

Sandy Soils

Rhus canadensis
Fragrant Sumac
Caragana arborescens
Siberian Pea Tree
Forsythia intermedia
Golden Bell
Tamarix (*In Variety*)
Tamarisk
Lonicera tartarica
Tartarian Bush Honeysuckle
Rosa rugosa
Japanese Rose
Rosa setigera
Michigan Prairie Rose
Berberis Thunbergii
Thunberg's Barberry

Rhus glabra
Sumac
Cotinus coggygria
Purple Fringe
Spiræa Vanhouttei
Van Houtt's Spirea
Rosa setigera
Michigan Prairie Rose
Rhus (*In Variety*)
Sumac
Sorbaria sorbifolia
Ash-leaved Spirea
Spiræa tomentosa
Hardhack

ROSES

Hybrid Perpetuals

For cut flowers

(Half hardy, requiring some protection over winter)

Frau Karl Druschki (*white*)
Mrs. John Laing (*pink*)
General Jacqueminot (*brilliant crimson*)
Ulrich Brunner (*cherry red*)
Paul Neyron (*deep rose*)
Mrs. R. G. Sharman Crawford (*deep rose-pink*)
John Hopper (*bright rose*)
Marshall P. Wilder (*cherry carmine*)
Prince Camille de Rohan (*deep crimson*)

Hardy Climbing

Baltimore Belle (*white tinted pink*)
Crimson Rambler (*bright crimson*)
Dorothy Perkins (*pink*)
Lady Gay (*rose pink*)
White Dorothy Perkins (*white*)

For Landscape Effect

Rosa rugosa (*Japan rose*)
Rosa setigera (*Michigan Prairie rose*)
Rosa rubiginosa (*Sweet briar*)
Rosa rubrifolia (*Red-leaved rose*)

Hardy Bush

Austrian Yellow
Persian Yellow
Common Moss
Blanche Moreau (*white*)
Princess Adelaide (*pale rose*)
Gracilis (*deep pink*)

VINES FOR SPECIAL PURPOSES

Flowering Vines

Clematis Jackmanii
Purple clematis
Clematis paniculata
White Flowering Clematis
Campsis radicans
Trumpet Vine
Roses, Wichuraiana Hybrids
Crimson Rambler
Dorothy Perkins.
Wisteria sinensis
Chinese Wisteria
Lonicera japonica Halliana
Hall's Japan Honeysuckle

Vines for Covering Brick, Stone and Masonry

Parthenocissus tricuspidata Veitchii
Boston Ivy
Euonymus radicans
Climbing Euonymus
Parthenocissus quinquefolia Engelmannii
Engelmann's Ampelopsis

Vigorous Climbing Vines with Heavy Foliage

Celastrus scandens
Bittersweet
Campsis radicans
Trumpet Vine
Parthenocissus quinquefolia
Virginia Creeper
Lonicera (*In Variety*)
Honeysuckle
Wisteria sinensis
Chinese Wisteria
Aristolochia macrophylla
Dutchman's Pipe
Clematis paniculata
White-flowering Clematis

PERENNIALS FOR SPECIAL PURPOSE

Standard Types for General Planting

Iris germanica
German Iris
Phlox paniculata
Garden Phlox
Pæonia
Peony
Delphinium
Larkspur
Aster
Aster
Rudbeckia laciniata
Golden Glow
Coreopsis lanceolata
Lance-leaved Tickseed
Dianthus barbatus
Sweet William
Aquilegia
Columbine
Chrysanthemum
Chrysanthemum
Althæa rosea
Hollyhock

Little Known Perennials that Should be More Largely Used

Achillea Ptarmica var. Boule de Neige
Ball of Snow
Monarda didyma
Bee Balm
Hosta plantaginea
Day Lily
Gypsophila paniculata
Baby's Breath
Papaver orientale
Oriental Poppy
Phlox subulata
Moss Pink
Hibiscus moscheutos
Marsh Mallow
Gaillardia aristata
Blanket Flower
Narcissus poeticus
Narcissus
Anemone japonica
Japanese Windflower
Iberis sempervirens
Evergreen Candytuft
Aquilegia formosa hybrids
Columbines
Chrysanthemum coccineum
Feverfew
Lobelia cardinalus
Cardinal Flower
Eulalias (*In Variety*)
Plume Grasses

CHOICE VARIETIES OF PEONIES

White

Early
Festiva Maxima
Madame de Verneville
Mid-season
Baroness Schroeder
Late
Marie Lemoine
Couronne d'Or

Pink

Early
Delicatissima
Mid-season
Therese
Madame Emile Lemoine
Albert Crousse
Late
Dorchester

Deep Pink

Early
Alexandriana
Mid-season
Modeste Guerin
Late
Livingston
Monsieur Boncharlat Aine

Red

Early
Augustin d'Hour
Mid-season
Felix Crousse
Late
Henry Demay

CHOICE VARIETIES OF PHLOX

Mrs. Jenkins (*early white*)
Fraulein Von Lassburg (*large white*)
Jeanne d'Arc (*late white*)
Bridesmaid (*white, carmine center*)
Henri Murger (*white, carmine center*)

Europa (*white, carmine eye*)
W. C. Egan (*soft pink*)
Selma (*pink, red eye*)
Pantheon (*brilliant rose*)
Rynstrom (*deep salmon pink*)
Siebold (*bright scarlet*)
Rosenberg (*reddish violet with red eye*)
B. Comte (*purple*)

CHOICE VARIETIES OF GERMAN IRIS

Atropurpurea (*purple*)
Fairy (*ivory white, pale violet veins*)
Florentina (*white, tinged with blue*), early
Gracchus (*yellow and crimson*), early
King of Iris (*yellow and brown*)
Madame Chereau (*white, tinged blue*)
Madame Pacquette (*bright rosy claret*), early
Maori King (*rich golden yellow*)
Mrs. H. Darwin (*white, violet veins*), early
Pallida Dalmatica (*lavender, blue*)
Queen of May (*lilac, pink*)
Silver King (*silvery white*), early

ANNUALS FOR SPECIAL PURPOSES

Annuals Valuable for Cut Flowers

Asters, late branching
Sweet Peas
Cosmos, early flowering
Pansies
Nasturtiums, dwarf
Mignonette
Bachelor Buttons
Zinnias
Snapdragon
Corn Flower
Heliotrope
Stocks
Dianthus

Annuals for Garden Effects

For edgings:
Sweet Alyssum
Lobelia
English Daisy
Dwarf Cockscomb
Dusty Miller
Ageratum
Candytuft

For bedding effects:
Annual Phlox
Verbena
Annual Poppies
Petunia, var. Rosy Morn
African Daisy
Marigold
Balsam
Celosia
Portulaca

Tall growing annuals:

Castor Oil Bean
Sunflower
Cosmos, late

Annual Vines

Cyperus vine	Wild Cucumber
Balloon Vine	Morning Glory
Gourd, Ornamental	Hop Vine
Climbing Nasturtiums	Moon Vine
Scarlet-runner Bean	Cobea

HARDY PERENNIALS FOR CUT FLOWERS*

One of the great joys incidental to the possession of a hardy garden is the privilege of cutting flowers for the decoration of the home or as a friendly gift that will never go unappreciated. May and June are prodigal months in the garden, but an unlimited supply of flowers may not be available during late summer and fall without a careful selection of varieties. We, therefore, submit the following good cut-flower kinds to facilitate your selection:

July-Flowering Subjects

Achillea	Hemerocallis, as noted	Pentstemons
Aconitum autumnale	Gaillardias	Phlox suffruticosa vars.
Anchusa italica vars.	Heuchera	Scabiosa
Shasta Daisies	Hollyhocks	Spiræa (Astilbe) Arendsii vars.
Delphiniums	Lilium tigrinum vars.	Stokesia
Digitalis	Lychnis chalcedonica	
Helenium Hoopesii		

August-Flowering Subjects

Achillea	Heuchera	Statice
Aconitum autumnale	Hollyhocks	Stokesia
Boltonia	Liatris vars.	Tritoma
Shasta Daisies	Lobelia cardinalis	Veronica longifolia subsessilis
Coreopsis	Monarda, Cambridge Scarlet	Veronica paniculata
Delphinium	Hardy Phlox	Veronica spicata
Funkia subgrandiflora	Physostegia	Veronica virginica
Gaillardia	Platycodon	
Heliopsis	Rudbeckia	

September-Flowering Subjects

Anemone japonica vars.	Liatris vars.	Stokesia
Hardy Asters, as noted	Lobelia cardinalis	Tritoma
Boltonia	Hardy Phlox	Veronica longifolia subsessilis
Delphinium	Physostegia	Veronica paniculata
Eupatorium	Rudbeckia	Veronica spicata
Gaillardia	Scabiosa	Veronica virginica
Helenium	Statice	
Heliopsis		

October-Flowering Subjects

Anemone japonica vars.	Hardy Asters, as noted	Hardy Phlox
Hardy Chrysanthemum	Hardy Gaillardia	Hardy Tritoma

* Courtesy of N. A. Pierson, Cromwell, Conn.

Perennials Suitable for Shady Locations in the Hardy Border

Adenophora. Partial shade or full sun.
Ajuga, all varieties. Partial shade or full sun.
Anemone sylvestris. Partial shade.
Anemone pennsylvanicum. Partial shade or full sun.
Anemone vitifolia. Partial shade.
Aquilegia, all varieties. Partial shade or full sun.
Convallaria (Lily-of-the-Valley). Partial shade.
Delphinium. Partial shade or full sun.
Dielytra. Partial shade or full sun.
Digitalis. Partial shade or full sun.
Funkia, all varieties. Partial shade or full sun.
Hemerocallis. Partial shade or full sun.
Hepatica. Partial shade.
Heuchera. Partial shade or full sun.
Hypericum Moserianum. Partial shade or full sun.
Iris germanica. Partial shade or full sun.
Iris pumila. Partial shade or full sun.
Lilies, Hardy. Partial shade or full sun.
Lobelia cardinalis. Partial shade or full sun.
Myosotis. Partial shade.
Pachysandra terminalis. Partial shade or full sun.
Peonies. Light shade or full sun.
Phlox divaricata. Partial shade or full sun.
Phlox canadensis. Partial shade or full sun.
Platycodon. Partial shade or full sun.
Polemonium. Partial shade or full sun.
Polygonatum. Partial shade.
Primula, all varieties. Partial shade.
Spiræa (Astilbe). Partial shade or full sun.
Tradescantia. Partial shade or full sun.
Veronica longifolia. Partial shade or full sun.
Veronica virginica. Partial shade or full sun.
Viola cornuta varieties. Partial shade or full sun.

Desirable Rock-Garden Plants

Arenaria montana. Full sun.
Ajuga, all varieties. Partial shade or full sun.
Alyssum, all varieties. Full sun.
Anemone pennsylvanicum. Partial shade.
Anemone pulsatilla. Partial shade.
Anemone sylvestris. Partial shade.
Armeria, all varieties. Full sun.
Aubrietia, all varieties. Full sun.
Asters, dwarf varieties. Full sun.
Campanula carpatica varieties. Full sun.
Cerastium, all varieties. Full sun.
Convallaria (Lily-of-the-Valley). Partial shade.
Delphinium chinensis varieties. Partial shade or full sun.
Dianthus, Hardy Pinks. Full sun.
Dielytra formosa. Partial shade.
Draba, all varieties. Partial shade or full sun.
Euphorbia. Full sun.
Genum, all varieties. Full sun.
Gentians. Partial shade.
Gypsophila repens varieties. Full sun.
Helianthemum, all varieties. Full sun.
Hepatica triloba. Partial shade.
Heuchera, all varieties. Partial shade or full sun.
Iberis, all varieties. Full sun.
Inula ensifolia. Full sun.
Iris, dwarf varieties. Partial shade or full sun.
Linum, all varieties. Full sun.
Lychnis, all varieties except Chalcedonica. Full sun.
Myosotis. Full sun.
Œnothera, all varieties. Full sun.
Pachysandra terminalis. Partial shade or full sun.
Papaver nudicaule. Full sun.
Papaver alpinum. Full sun.
Pentstemon heterophyllus. Full sun.
Phlox amœna. Full sun.
Phlox divaricata canadensis. Partial shade or full sun.
Phlox divaricata Laphamii. Partial shade or full sun.
Phlox pilosa splendens. Partial shade or full sun.
Phlox subulata varieties. Full sun.
Platycodon, dwarf varieties. Full sun.
Plumbago Larpentæ. Partial shade or full sun.
Polemonium reptans. Partial shade or full sun.
Primula, all varieties. Partial shade.
Saponaria ocymoides. Full sun.
Saxifraga, alpine varieties. Partial shade.
Sedum, all varieties. Full sun.
Stokesia. Full sun.
Veronica prenja. Full sun.
Veronica incana. Full sun.
Viola (Tufted Pansies). Partial shade or full sun.

CHAPTER XXIV

CONCRETE

Material necessary.—

1. Cement, standard grade.
2. Sand, all grains that pass through one-quarter inch.
3. Gravel and crushed stone. Should be clean, having no soil, clay or vegetable matter mixed with it. It grades from one-quarter-inch screening to one and one-half-inch material. In using crushed stone, eliminate the dust.
4. Water. Do not use acid or alkali water. Should be clean.

Miscellaneous tools (U. S. Dept. of Agr.).—The following is a list of the tools and plant to be used in mixing, giving sizes, quantities, etc.:

The lumber for the concrete board for a two-bag batch, nine feet by ten feet in size, is as follows:

Nine pieces seven-eighths-inch by twelve inches by ten feet, surfaced on one side and two edges.

Five pieces two inches by four inches by nine feet, rough.

Two pieces two inches by two inches by ten feet, rough.

Two pieces two inches by two inches by nine feet, rough.

The lumber for the concrete board for a four-bag batch, twelve feet by ten feet in size, is as follows:

Twelve pieces seven-eighths-inch by twelve inches by ten feet, surfaced on one side and edges.

Five pieces two inches by four inches by twelve feet, rough.

Two pieces two inches by two inches by ten feet, rough.

Two pieces two inches by two inches by twelve feet, rough.

For the runs, planks two, two and one-half or three inches thick and ten or twelve inches wide are needed.

The measuring boxes for the sand and stone or gravel should have the following dimensions:

For a two-bag batch with the 1:2:4 mixture:

Four pieces one inch by eleven and one-half inches by two feet rough (for the end of the sand and stone boxes).

Two pieces one inch by eleven and one-half inches by four feet, rough (for the sides of the sand box).

Two pieces one inch by eleven and one-half inches by six feet, rough (for the sides of the stone box).

(It should be noted that the two pieces four feet long and the two pieces six feet long have an extra foot in length at each end for the purpose of serving as a handle.)

For a two-bag batch with the 1 : 2½ : 5 mixture:

Two pieces one inch by eleven and one-half inches by two feet (for the ends of the sand box).

FIG. 213.—Tools used in making concrete on the farm. *a*, Rake; *b*, wheelbarrow; *c*, wooden float; *d*, square-nosed shovel; *e*, round-nosed shovel; *f*, bucket; *g*, water barrel; *h*, gravel screen; *i*, tamper.—*U. S. Dept. of Agriculture.*

Two pieces one inch by eleven and one-half inches by two and one-half feet (for the ends of the stone box).

Two pieces one inch by eleven and one-half inches by four and one-half feet (for the sides of the sand box).

Two pieces one inch by eleven and one-half inches by six feet (for the sides of the stone box).

(As in the preceding case, the two pieces four and one-half feet long and the two pieces six feet long have an extra foot in length at each end to serve as handles).

For a four-bag batch (these figures can be obtained by doubling the cubic contents of the boxes, as shown above).

Shovels: No. 3, square point.

Wheelbarrows: At least two are necessary for quick work, and those with a sheet-iron body are to be preferred.

Garden rake.

Water barrel.

Water buckets, two-gallon size.

Tamper: Four inches by four inches by two feet six inches, with handles nailed to it.

Garden spade or spading tool.

Sand screen, which can be made by nailing a piece of one-quarter-inch mesh wire screen, two and one-half by five feet in size, to a frame made of boards two by four inches.

DETERMINATION OF QUANTITIES

(U. S. Department of Agriculture)

QUANTITIES OF MATERIALS AND THE RESULTING AMOUNT OF CONCRETE FOR A TWO-BAG BATCH

Kinds of concrete mixture	Proportions by parts			Materials			Concrete (cubic feet)	Sizes of measuring boxes (inside measurements)		Water for medium wet mixture (gallons)
	Cement	Sand	Stone or gravel	Cement (bags)	Sand (cubic feet)	Stone or gravel (cubic feet)		Sand	Stone or gravel	
1:2:4...	1	2	4	2	3¾	7½	8½	2 feet by 2 feet by 11¼ inches	2 feet by 4 feet by 11¼ inches	10
1:2½:5..	1	2½	5	2	4¾	9⅜	10	2 feet by 2 feet 6 inches by 11¼ inches	2 feet 6 inches by 4 feet by 11¼ inches	12½

The number of cubic feet of concrete that will be required for the work in question should first be calculated. By multiplying this number by the number under the proper column, as shown in Table II below, the amount of cement, sand, and stone or gravel can be found.

QUANTITIES OF MATERIALS IN ONE CUBIC FOOT OF CONCRETE

MIXTURE OF CONCRETE	CEMENT (by barrels)	SAND (by cubic yards)	STONE OR GRAVEL (by cubic yards)
1:2:4	0.058	0.0163	0.0326
1:2½:5	.048	.0176	.0352

Example.— Let us suppose that the work consists of a concrete silo requiring in all nine hundred and thirty-five cubic feet of concrete, of which seven hundred and fifty cubic feet are to be 1 : 2 : 4 concrete, and one hundred and eighty-five cubic feet are to be 1 : 2½ : 5 concrete. Enough sand and cement are also needed to paint the silo inside and outside, amounting in all to four hundred square yards of surface, with a 1 : 1 mixture of sand and cement. One cubic foot of 1 : 1 mortar paints about fifteen square yards of surface, and requires 0.1856 barrel of cement and 0.0263 cubic yard of sand. The problem thus works out as follows:

CEMENT	Barrels
For the 750 cubic feet of 1:2:4 concrete (750×0.058)......	43.5
For the 185 cubic feet of 1:2½:5 concrete (185×0.048)....	8.9
For painting (400÷15×0.1856)...........................	4.9
Total amount of cement.............................	57.3
SAND	Barrels
For 750 cubic feet of 1:2:4 concrete (750×0.0163).........	12.23
For 185 cubic feet of 1:2½:5 concrete (185×0.0176).......	3.26
For painting (400÷15×0.0263)...........................	.70
Total amount of sand.............................	16.19
STONE OR GRAVEL	Barrels
For 750 cubic feet of 1:2:4 concrete (750×0.0326).........	24.5
For 185 cubic feet of 1:2½:5 concrete (185×0.0352).......	6.5
Total amount of stone or gravel......................	31.0

Thus the necessary quantities of materials are about fifty-seven and one-half barrels of Portland cement, about sixteen and one-quarter cubic yards of sand, and thirty-one cubic yards of stone or gravel. It is always wise to order two or three

extra barrels of cement if the dealer is at considerable distance, as this avoids any possible trouble that a shortage might cause.

In case a natural mixture of bank sand and gravel is used, the following table should be consulted for the quantities of the mixture:

QUANTITIES OF MATERIALS AND THE RESULTING AMOUNT OF CONCRETE FOR A TWO-BAG BATCH, USING A NATURAL MIXTURE OF BANK SAND AND GRAVEL

KIND OF CONCRETE MIXTURE	PROPORTIONS BY PARTS		MATERIALS		Concrete (cubic feet)	SIZES OF MEASURING BOXES, MIXTURE OF SAND AND GRAVEL	Water for medium wet mixture (gallons)
	Cement	Natural mixture of sand and gravel	Cement (bags)	Natural mixture of sand and gravel (cubic feet)			
1:4	1	4	2	7½	8¼	2 feet 6 inches by 4 feet by 11¼ inches.	10
1:5	1	6	2	9½	10	2 feet by 4 feet by 11¼ inches	12½

PRACTICAL HINTS

Use care in selecting the right kind and proportions of sand, gravel and crushed stone.

Cement usually hardens thirty minutes after it is wet if allowed to stand.

Do not expose newly set concrete to the sun for four to five days. Protect newly set concrete from frost.

Keep cement in a dry place on an elevated wooden floor.

If cement is left out of doors over night cover with canvas.

Screen sand at the pit and save time, hauling and labor.

Sand of various sized grains is most desirable, giving more strength.

Never use sand that softens in water.

Large pebbles and stone may be used in constructing heavy foundations and abutments.

For reinforced concrete work, material that passes through one-inch rings is recommended.

Mix thoroughly. Concrete having a gray streaky appearance is not well mixed.

Mix sand and cement thorougly before applying the water.

Do not wash or allow the mixture to flow off. Mix from the center out until the entire pile is saturated with water.

Gravel and crushed stone should be moistened before mixing with cement and sand.

All forms should be placed before concrete is mixed.

Clean concrete from tools and boards when not in use and while the mixture is soft.

Linseed or cylinder oil will prevent tools from rusting.

CHAPTER XXV

RUNNING WATER FOR HOUSE AND OUTBUILDINGS

By H. F. Miller

The very first point to consider in preparing a new homestead or in remodeling an old one is the installation of a water supply and the proper arrangement of the rooms in the house which are to have fixtures supplied with water.

What fixtures to install.— If there is a bedroom downstairs, this should have a lavatory. The kitchen should have at least one sink, and if there is a man's washroom, which is a great convenience, this should also have a large sink. The bathroom should have a standard size enameled tub, preferably fitted with shower attachment; a good lavatory, and a standard make of closet. The laundry in the basement should have a two-compartment built-in tub. The laundry tub should be sloped toward the trays and be fitted with a floor trap at the lowest point.

Points to consider in selecting a pumping equipment.— In planning for a water system the following questions should be considered in the order given:

1. From what source will be water be obtained?
2. How much water will you require each day?
3. What type of system do you wish to install?
4. How is pump to be operated?

1. Source of water supply.— The water for house service can be obtained from one or more of the following sources: Wells, springs, cisterns, lakes or running streams. The thing to decide now is whether the supply is to be taken from a shallow well (cistern, spring or other source near the surface of the ground) or whether it is to be taken from a deep well, or both.

Where the well water is too hard to be satisfactory for bath and laundry purposes many people prefer to have two pumps, one to supply soft water from cistern and the other to furnish the well or spring water for drinking purposes. Where a tank system is installed in such cases it is necessary, of course, to have two separate tanks.

Water used from springs or surface sources, like rivers and lakes, should always be examined for impurities before it is used for drinking purposes, as impure water is one of the frequent

causes of disease. The same thing applies to the shallow well, as it is very apt to receive impurities from the surface of the ground which have not passed through enough earth for proper purification. Usually the best source of all is the deep well, as the water from this source is safe and in most cases cooler and more palatable. Springs and lakes are just as satisfactory, however, and sometimes more so if the water is found to be pure.

a. Shallow wells.— In this chapter shallow wells are considered as those in which the water level is near enough to the surface of the ground so that water can be drawn up by suction; springs, cisterns, lakes and rivers can come under this head in selecting the equipment. The suction lift is usually considered about twenty feet, but it is a quantity that will vary with the atmospheric pressure of the locality, being practically twenty-two feet at sea level. The best practice is to eliminate the suction lift, if possible, by having the cylinder under water; in no case is it good practice to have the cylinder more than twenty-two feet above the water level. With pumps which have the cylinder separate from and below the standard, the most common type, the distance from the surface of the ground to the water level can be more than twenty feet as the cylinder will be below the surface. The cylinder is the pump proper, and all distances should be measured from it.

b. Deep wells.— Deep wells are considered as those in which the water is too far below the surface of the ground to be drawn up by suction. In these wells it is always necessary to have the cylinder and standard separate, connected by a section of pipe. The length of this pipe should be sufficient to bring the cylinder within suction distance of the water. Here again, however, the best practice is to have the cylinder below the water level, as this keeps the cylinder primed and the valves will not dry out if the pump is not used for a long time.

c. Location and construction.— In providing a well there are two important points to be considered: First, its location; second, its construction. Both of these factors will affect the purity and healthfulness of the water obtained. If the water is taken from a shallow well, the well should be at least thirty-five or forty yards from any barn yard, cesspool, vault or other source which might contaminate the water by seepage through the soil. If possible, it should be always located on higher ground than these impurities so the natural flow of water will not be from them toward the well. Where a deep cased well is used, the danger of contamination is practically eliminated. For this

reason a good many wells of this type are driven under the basements of barns, dairy buildings, etc., and the pump located in the basement where it can be operated by the same line shaft or the same engine that is used to operate cream separators, feed cutters and other equipment.

The construction of the well should be such that the surface water cannot enter it without having passed through a good depth of soil for filtration. The type of construction can be one of three general classes, dug, driven or drilled. The different types of deep and shallow wells are shown below.

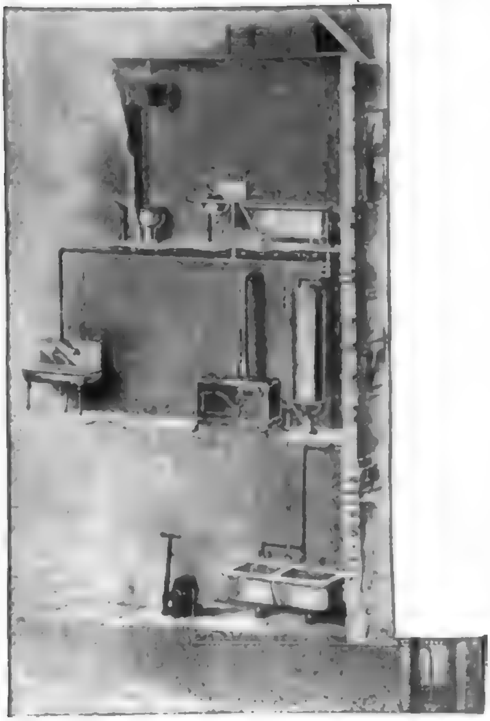


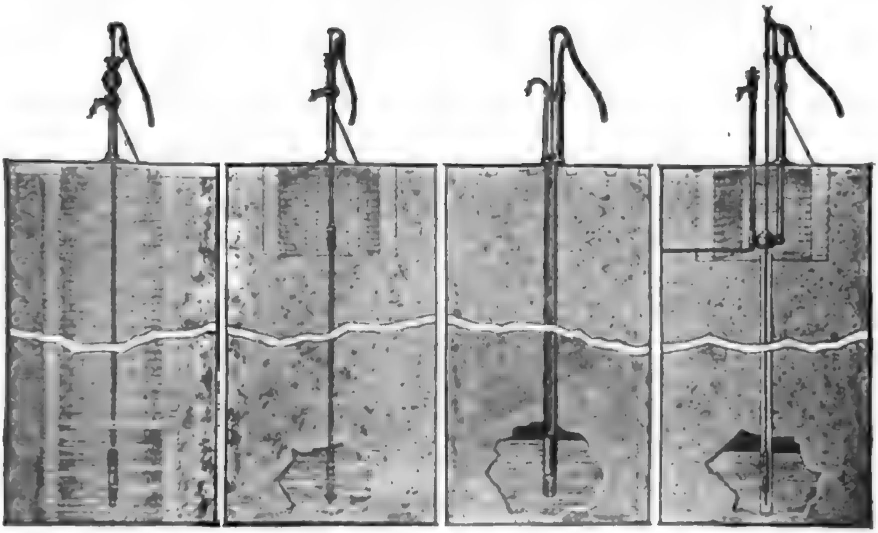
FIG. 214.—Typical layout of running water system. Hand operated pump is used in this case to take water from well and force it to gravity tank in attic.

Dug wells.—Fig 215 (a) shows the dug type, which is made by digging a large hole and lining it with masonry. In a properly constructed well this masonry should be made tight by cementing for a depth of at least ten feet from the top, so that the surface water cannot enter without passing through this depth of soil. The masonry should be carried eight or ten inches above the surface and surrounded with cement, sloping from the well, and the cover should be made absolutely tight. A trough should be provided under the pump spout, if the spout discharge is used, so the waste water will be carried away from the well. Another plan sometimes followed is to place the pump at one side of the well instead of having it directly over the well as shown in Fig. 1.

Driven wells.—Fig. 215 (b) shows the driven type. This well is constructed by attaching a well point, such as illustrated, to the end of the pipe and driving the point into the ground until water is reached. The cylinder is then installed in a dry well as shown where it is easily accessible. The point is provided

with a short length of pipe with perforations which permit the water to enter the pipe and keep out the gravel and sand. This type is essentially for shallow wells, as with the cylinder in the dry well water cannot be drawn up more than twenty feet by suction. If a driven well is wanted and the water is more than twenty feet below the surface, it is necessary to dig a deep dry well so the cylinder can be installed below ground within suction distance of the water.

Drilled wells.—Fig. 215 (c) shows a drilled well, usually the best type of all, for no impurities can enter from the surface.



a b c d

FIG. 215.—Types of wells.

This type of well consists of a small hole from three to fifteen inches in diameter drilled through the various layers of surface soil, clay and rock until a pure stream of water is reached. This hole is lined with an iron casing which prevents its caving in and keeps out all the water except that which enters at the bottom. The type of well can pass through as many water-bearing soils as desired, and none but the water of the lowest streams will enter. The casing is large enough to accommodate the pump cylinder so that it can be lowered below the water surface or as near the water as is necessary, and water can be pumped from any required depth.

Fig. 215(d) shows a drilled well with a dry well installed above it to accommodate the lower half of a pump made for underground discharge.

If the source of supply and the tank are a considerable distance apart so that pipes one hundred feet long or more have to be laid between, the friction in the pipe will act the same as though there were a small increase in the height the water has to be pumped. In such cases this friction should be considered in measuring the head.

If an elevated tank is a considerable distance from the cocks where the water is to be used, it should be placed a little higher than would otherwise be necessary to make up for the loss of pressure in the long pipe lines. A good plan is to have the bottom of the tank ten feet above the highest cock; then ample pressure will be insured at all cocks.

2. **Amount of water required.**—After determining the source of supply, the first thing to be done before the proper pump can be selected is to figure the amount of water required per day. This can be estimated pretty closely by using the following table. This information is necessary to determine the size and

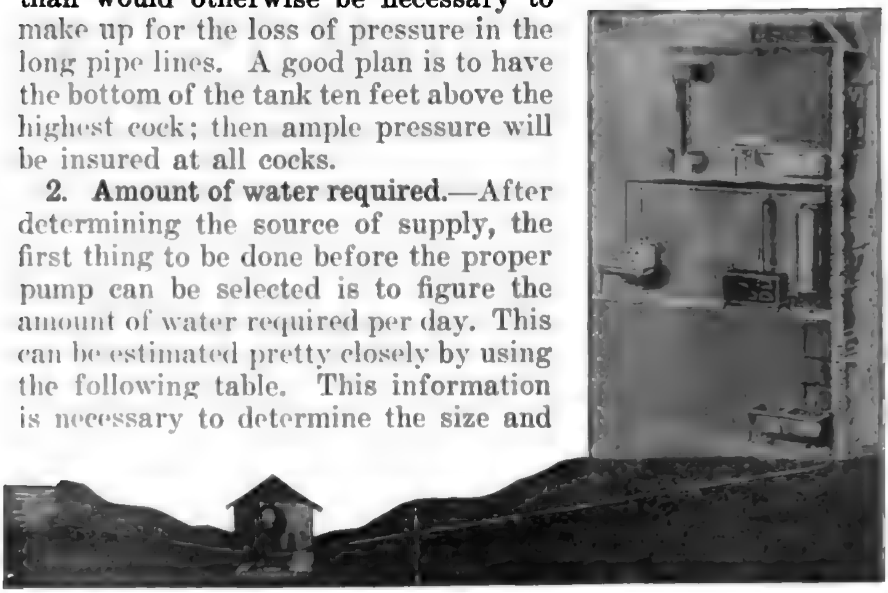


FIG. 216.—Gravity system with ram. Tank located in the attic.

capacity of the pump to be used and, in the case of tank systems, to determine also what capacity the tanks should have.

Each member of the family for all purposes, including kitchen, bath, water closet, laundry, etc.	will require 25 gallons
Each horse	will require 10 gallons
Each cow	will require 10 gallons
Each hog	will require 2 gallons
Each sheep	will require 1 gallon

If water is to be used in the house only, and there is a family of six, the tank should have a capacity of $6 \times 25 = 150$ gallons for a one-day supply.

If water is to be used in the house and barn, and there is a family of six, with eight horses, twelve cows, twenty hogs, and ten sheep to be provided for, the tank should have a capacity of

$6 \times 25+8 \times 10+12 \times 10+20 \times 2+10 \times 1=400$ gallons for a one-day supply.

3. Selecting the system.— There are two general types of running water systems, viz.:

a. Gravity system.— In this system the water is pumped into an elevated tank, located higher than the highest faucet, so that the water will flow by gravity. Pumps for this system can be operated by hand, windmill or power, or, where there is running water, an hydraulic ram can be used.

Where an electric motor is used to operate the pump, an automatic device can be used to start the motor when the tank becomes empty and to stop it when the tank is full.

b. Pneumatic pressure system.— By this system the water is pumped into an air-tight tank, usually located below the ground to keep the water cool for drinking purposes and free from the dust as well as to protect it from freezing. The water is forced up to the faucets by the air pressure in the tank. Air, to take off leakage through the water, is pumped into the tank either by a separate air pump or sometimes by an air pump attachment which fits onto the water pump and which causes it to pump air with the water. Pumps for this system can be operated either by hand or power.

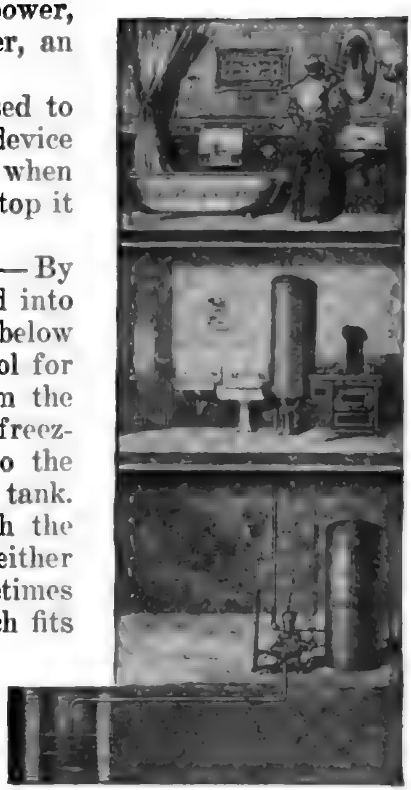


Fig. 217.—Typical pneumatic pressure system with hand operated pump.

Where an electric motor is used to operate the pump, an automatic device can be used which will start the motor when the minimum pressure is reached and stop it when it reaches the maximum.[1]

4. How is pump to be operated?—Having determined the source of supply and figured the capacity required, it is neces-

[1] One great advantage of a tank system is its value as a protection against fire. This is a point to be taken carefully into consideration when selecting a system, as it is a great advantage to have water under pressure, such as is afforded by either the elevated or pneumatic tank systems, in case of fire emergencies.

sary to decide which general type of equipment to install—whether one operated by hand, windmill, gasoline engine or other power, or by an hydraulic ram which operates automatically, using the force of a few feet of fall between the source of supply and ram.

When to use hand, windmill or power pumps.—Hand-operated pumps are recommended when small quantities of water are required, as for barn service only, or for trough service only.

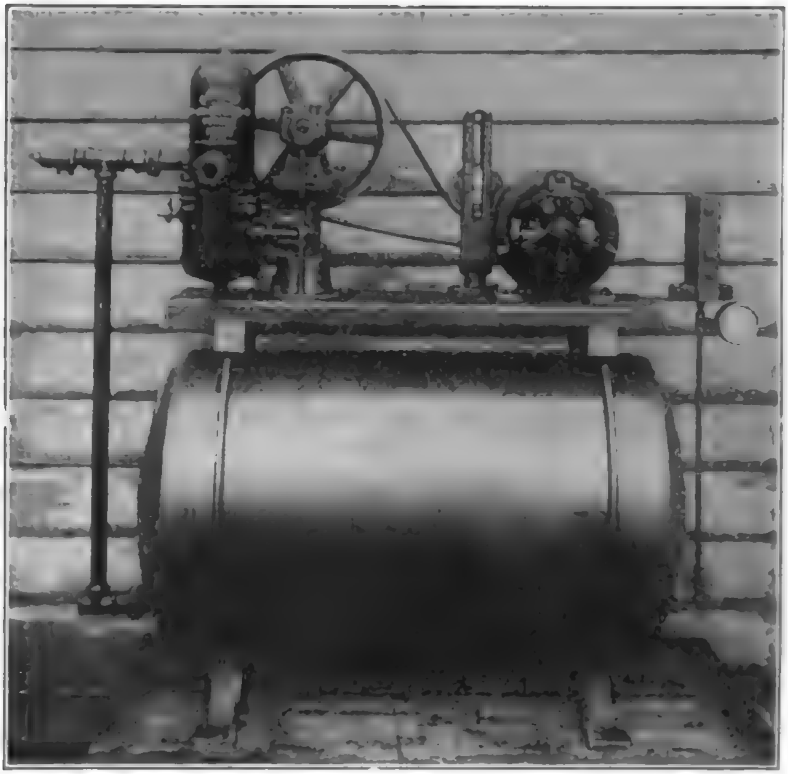


FIG. 218.—Electric motor drive complete water system, consisting of thirty-gallon tank, three gallons per minute, pump belted to one-quarter horse power motor, automatic electric starter, pressure gauge and relief valve. Can be furnished with 110 or 220 volt A. C. or D. C. motor or with thirty-two-volt motor for operation on farm lighting system.

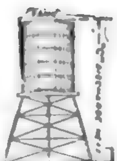
When water is wanted sufficient to supply barn, house, trough and perhaps other outbuildings, the windmill, power or hydraulic ram equipments should be used.

The windmill has the advantage over the hand system in that it eliminates the manual labor. As the windmill cannot be depended upon at all times, however, it is necessary to use a

larger tank with this system than with the others so there will be a reserve supply in the tank to tide over days in which there is not sufficient breeze to operate the mill.

The power pump driven by a gasoline or kerosene engine, electric motor or water wheel is an ideal equipment where running water is needed in any quantity for the house, barn, trough, etc. It eliminates the manual labor and is independent of weather conditions; water can be pumped whenever it is desired. The expenses for gasoline or other fuel is very small; while the engine can be made portable and used to great advantage for grinding feed, sawing wood, winnowing grain, separating cream or other work about the farm.

Improved hydraulic rams.—The hydraulic ram is a self-acting pump which utilizes the momentum of a slight fall of water to force a part of the water



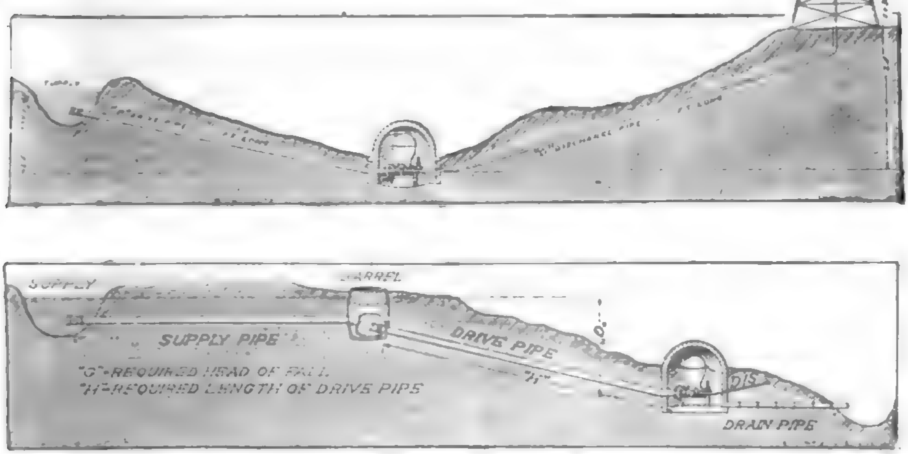


Fig. 219.—These drawings show how ram and pipe should be installed and also indicate data required by manufacturer before proper ram can be recommended.

to an elevation many times as high as the fall to operate the ram. The simplicity, effectiveness and durability of this machine make it one of the most useful as well as the most economical of the equipments available for forcing water to distant and elevated points.

A very slight fall only is required to operate the ram, but as the amount of fall is increased its operation becomes more powerful, and it will force the water in a proportionately larger flow or to a proportionately higher elevation. The amount of water delivered, or the proportion of the water raised to the amount wasted

in operating the ram, varies with the amount of fall and height to which it is elevated. An increase in available fall or a decrease in the height the ram has to elevate the water will cause a corresponding increase in the amount of water delivered by the ram.

Rams are used for a large variety of pumping duties, such as supplying water for dwellings, hotels, factories, railway tanks, stock watering troughs and so on. Water can be used directly from the ram or from a storage tank which is kept filled by the ram. The more common practice is to use the storage tank, as in this way a large supply is always available. Water can then be drawn from the tank as rapidly as desired for running water supply for bath room, kitchen and closet in the house, for watering the stock at the barn or for fire protection, irrigation, etc. The ram operates continuously, day and night, consequently the water used during times when there is a large demand on the tank is replaced during periods when the demand is low.

Fig. 220.—Hydraulic ram for filling tanks not more than 120 feet above the source of supply.

The advantages of the hydraulic ram are that its operation involves no labor or expense, and, once started, it will continue to pump day and night without attention, as long as the supply of water is sufficient.

Construction.— The improved design of impetus valve used on Gould's Rams gives exceptionally high efficiency and reliable operation. The air chamber is large and all parts are strongly built and carefully proportioned.

The sectional illustration shows the various working parts of the ram, and gives a good idea of its strength and simplicity. This sectional view illustrates the working parts of a ram, suitable for streams supplying eleven to twenty gallons per minute, and for raising from fifty-five to one hundred gallons per hour to elevations up to one hundred and twenty feet. By referring to this view, it will be noted that the construction consists of the air chamber; "A," the body; "B," the shifting valve or air inlet; "C," the check or inner valve; "E," located between the supply pipe and the air-chamber, and the impetus valve, "F," located at the end of the supply pipe.

How the ram operates.— The water flows down through the supply pipe "G," passing into "B" and on through the outlet in the impetus valve "F," until the constantly increasing pressure lifts this valve and closes it. This stops the flow of water in this direction, and the shock due to its sudden stoppage causes it to force open the check valve "E," which is the only other outlet. When sufficient water passes through "E" into the air-chamber "A," to relieve the pressure due to the sudden stoppage in "B," the check valve "E" closes, the impetus valve "F" opens again and the same operations are repeated. The air in the chamber "A," acts as a cushion, absorbing the shock and maintaining a steady, even flow of water through the delivery pipe "H." As shown by this description of the ram's action, a portion of the water is wasted to operate the ram, but the power which operates it is obtained at no cost, and no attention is required.

How to select a ram.— In order to determine the size, the ram should be for any certain service, the following data and measurements should be ascertained. The measurements referred to are illustrated in Fig. 8.

1. Quantity of water in gallons per minute available for supply.
2. Quantity of water in gallons required at discharge in twenty-four hours.
3. Vertical fall in feet, from supply to proposed location of ram "A."
4. Distance from supply to ram "B."
5. Vertical distance from ram to point of discharge "C."
6. Required length of discharge pipe from ram "D."

For example, suppose we wish to force water to an elevation of forty feet above the ram; by referring to the table below, we find that a No. 4 ram with a flow of seven gallons per minute delivered to the ram, with a fall (A) of five feet, through forty feet of drive pipe (B) will elevate about thirty-five gallons per hour, or eight hundred and forty gallons in twenty-four hours to a point forty feet above the ram.

PROPORTIONATE HEAD OF FALL GIVING HIGHEST EFFICIENCY IN OPERATION OF HYDRAULIC RAMS

TO DELIVER WATER TO HEIGHT OF	PLACE RAM UNDER	CONDUCTED THROUGH
20 feet above ram	3 feet head of fall	30 feet of drive pipe
30 " " "	4 " " " "	30 " " " "
40 " " "	5 " " " "	40 " " " "
50 " " "	7 " " " "	50 " " " "
60 " " "	8 " " " "	60 " " " "
80 " " "	10 " " " "	80 " " " "
100 " " "	14 " " " "	100 " " " "
120 " " "	17 " " " "	125 " " " "

*Any size ram may be operated under these conditions and will afford the following approximate delivery:

No. 2	requires	2 to 3	gals.	per	minute	and	will	deliver	10 to 15	gals.	per	hour
" 3	"	2 to 4	"	"	"	"	"	"	10 to 20	"	"	"
" 4	"	3 to 7	"	"	"	"	"	"	15 to 35	"	"	"
" 5	"	6 to 12	"	"	"	"	"	"	30 to 60	"	"	"
" 6	"	11 to 20	"	"	"	"	"	"	55 to 100	"	"	"
" 7	"	18 to 35	"	"	"	"	"	"	90 to 175	"	"	"
" 8	"	30 to 60	"	"	"	"	"	"	150 to 300	"	"	"

Installing the ram.—As a general rule, there should be one foot of fall for each seven feet of elevation; the ram should never be installed under less than three feet of fall, as this is the smallest fall under which it will operate. The fall between the source of supply and ram should not be greater than specified in the table above, as a greater fall causes an unnecessary strain on the ram and piping, and will interfere with the operation of the ram.

Both the drive and discharge pipes for the various ram sizes should have the diameters given in the tables, page 114; the length of the drive pipes should be the same as the vertical heights the water has to be lifted. For example, if the water has to be lifted a vertical height of forty feet, the drive pipe should be forty feet in length. When a double ram is installed it should be remembered that a separate drive pipe is required for each of the two rams.

Sometimes the lay of the land is such that it is impossible to get the required amount of fall for the drive pipe within the length the drive pipe should be according to the preceding rule.

* It is assumed that the smaller rams will not be selected for extremely high lifts, as the friction loss of water in a small drive and discharge pipe renders their use impracticable.

Where water supply will permit, always select ram of ample size for requirements.

When this is the case, the water should be piped from the source to a point within the required distance of the ram location. At this point, an open barrel can be placed and the drive pipe connected to it, as shown by Plate 11. This eliminates the friction loss caused by the water flowing through the long drive pipe that would otherwise be necessary.

The barrel can be connected to the source of supply by ordinary drain or soil pipes which should be at least a size larger than the drive pipe leading from the barrel to the ram.

It is good practice to place the ram in a small house, and bolt or fasten it securely to a timber or masonry foundation which will form a solid support for the ram and relieve the connecting pipes of undue strain. The ram should be elevated above the floor a sufficient distance so that the waste water cannot cover the snifting or air valve. If the drain from the ram is properly made, this height need not be very great, as the water will be carried off as rapidly as it flows out of the impetus valve.

The inlet of the drive pipe should be placed so that it will always be below the surface of the water. (This does not affect the fall as the fall is measured from the surface of the water, regardless of where the drive pipe enters the supply.) If the inlet is not below the surface sufficiently, the level may drop to a point where air will enter the drive pipe and cause the ram to stop.

All joints in the drive pipe should be air tight, or air will be drawn into the ram with the same results as when the water level drops below the inlet.

A strainer should always be placed on the inlet to prevent the pipe or ram from becoming choked with débris. It is a good plan to surround this strainer with a large wire netting to prevent it from becoming clogged. If possible, turns should be avoided in both the drive and discharge pipes. When this is not possible, the elbows or turns should be as large as possible, so there will be as slight obstruction to the free, easy flow of water as can be obtained.

How to start the ram.—When the ram is installed, all that is necessary to start it in operation is to press down the impetus valve, letting the water discharge, and then allowing it to rise. After repeating this operation a few times, the ram should continue to operate. If it does not, the impetus valve stroke is not properly adjusted. By changing the adjustment and trying again, the adjustment which gives the best operation will readily be obtained. This adjustment is made by adjusting the nuts on the impetus valve.

If the head happens to be too low, it will be shown by the fact that the operation of the valve will be weak; if the head is too high, the excessive pressure will prevent the valve from opening.

WATER SUPPLY DATA BLANK

Information Required for Making Recommendations for Water Supply Pump Installations

1. What is the source of supply? (Well, cistern, lake, spring or river) ....
2. If a well
   - What is the inside diameter? ....
   - What is the total depth? ....
   - How far from top of well to water level? ....
   - Has well been tested? ....
   - How much does water fall during continuous pumping? ....
3. If cistern, spring or river, what should be the vertical distance, from supply to place where pump could be located? ....
4. About how many gallons do you wish to pump per hour? ....
5. Do you wish a lift pump to deliver water at spout only? ....
6. Is pump to be placed in house or barn at some distance from the well? If so, about how far away from the well? ....
   And how much higher will pump be above top of well? ....
7. Do you wish to force water to place above pump? If so, how far above the pump? ....
   Do you wish to force water to place some distance away from pump? If so, how far away from the pump, measured on the level? ....
8. Make rough sketch on back showing about what are conditions, distance, etc.
9. Do you prefer elevated or underground tank? ....
10. How do you want to operate pump?
    - Hand ....
    - Windmill ....
    - Pump jack ....
    - If other power, what kind? ....

If Electric Motor, Give Following Information

(a) Is it direct current? .... If so, what voltage? ....
(b) Is it alternating current? .... If so, what voltage? ....
Cycles .... Phase ....

NOTE.—It is best to consult local lighting and power company concerning the kind of current available.
If gas, gasoline or steam engine give revolutions per minute and diameter of pulley.

Name ....

Address ....

Remarks ....

....

Dealer's name. ....

Address ....

RAM DATA BLANK

Information Required for Making Recommendations for Ram Installations

1. How many gallons per minute flow from spring or stream?............
2. How many gallons per 24 hours do you need at the tank?.............
3. What is the vertical fall in feet from the spring water level to the point where the ram will be located? (See "A" in diagram).......................
4. What is the distance between the point of supply and the point where the ram will be located? (See "B" in diagram)..........................
5. What is the vertical height in feet the water has to be lifted from ram to tank? (See "C" in diagram) ....
6. What is the length of the pipe necessary between the ram and tank? (See "D" in diagram) . . ..

Name . . ..

Address . . ..

Remarks . . ..

Name and address of your dealer..

....

While the illustrations show typical installations for house water supply only, these same systems can be made to supply water to cattle barns, stables and other outbuildings as well as watering troughs; also for sprinkling lawns, gardens and flower beds. Care should be taken in figuring the amount of water required in order that a tank and pumping equipment of sufficient capacity may be selected.

CHAPTER XXVI

USE OF EXPLOSIVES ON THE FARM

BY C. CRAIG AND A. LA MOTTE, DU PONT

Saving man power.— Lands have been cleared, drained and tilled for many years by the prodigal use of labor or man power.

Larger areas are yet to be cleared and further improvements must be made in millions of other acres in order to supply the ever-increasing demand for food and clothing.

Man is too intelligent and valuable in other ways to have his efforts and energy entirely consumed by the heavy forms of brute drudgery that can better be done by the employment of modern labor savers.

His knowledge, intelligence and energy are much more valuable to himself, the community, and the country at large when employed in directing the forces which have been placed at his disposal by nature and science.

The work must be done better than ever before, as the modern horse and power-drawn farm equipment cannot be used to advantage save on well-cleared lands.

Old methods of developing land by man power alone can be used no longer, for the greatest scarcity, at present, is labor. It is indeed so scarce, and when available so expensive, that it is becoming increasingly difficult to make developments or to install labor-saving devices in order to effect a saving in the future.

In many cases, there seems to be no escape from the condition; but in developing lands explosives, the modern conservers of man power, fill the needs and prove most efficient in doing the classes of work mentioned below.

No matter how difficult it may be to get men, explosives are always available and the demand for increased amounts can be quickly supplied for the job.

A saving in man power is a saving in money. Explosives are now included with horses, steam and gasoline as conservers of manual effort.

Dynamite is being used successfully as a time and labor saver in many ways, principal among which are the following:

For blasting stumps, boulders, ditches; draining swamps and wet spots; planting trees, vines, shrubbery and hedges; rejuvenating orchard soil; blasting post, telephone and telegraph pole holes; splitting logs; blasting wells, ice jams, log jams, cellars, trenches, sewers and gutters, fish ponds and small reservoirs; for dynamiting mud holes in roads; cleaning out and enlarging mill races, sluiceways, etc.; straightening channels; clearing right-of-way for highways; loosening gravel, rock, clay, etc.; breaking up castings; terracing hilly land to prevent washing of topsoil, and exterminating gophers and other burrowing animals.

Hauling and storing.— *Prompt removal from freight station.* — The law requires prompt removal of explosives, including blasting supplies, from freight stations. Those expecting shipments should arrange with the freight agent or station master to give notification immediately on arrival of shipment, which must be removed within twenty-four hours.

Hauling.— When transporting explosives by team, always keep the wagon boxes thoroughly swept. When using an open wagon, protect the load from sparks and rain with a robe or canvas cover. Lay the cases of explosives flat and so that they will not shift, and never haul detonators and explosives together. The detonators do not weigh much and can be brought along on some other trip.

If blasting caps are purchased from a dealer, in the tin boxes separate from the wooden shipping case, it is a good plan to put these boxes in a basket or wooden box with a horse blanket, coat, hay or anything else that would keep them from being roughly jarred and shaken on the way home.

Storing.— As soon as explosives are received, they should be stored in a dry, properly ventilated building, safe from fire and flying bullets, and far enough away from dwellings or roads to prevent loss of life should they be accidentally exploded. They should be kept under lock and key and where children or irresponsible persons cannot get at them.

If large quantities are to be stored for some time, a dry, well-ventilated, fire-proof and bullet-proof magazine, located in an out-of-the-way place should be provided. Fuse, wire, thawing kettles and blasting machines may be stored in the same building with dynamite, but blasting caps and electric blasting caps must never be stored in the same building, because they are more easily exploded than dynamite. It would be possible to explode them accidentally by a hard shock or jar which would not explode

dynamite. If detonators were to explode by themselves, they would not be likely to do much damage unless there were a great many of them, but if they were to explode in the same room with dynamite, they would probably cause the dynamite to explode.

Opening cases.— When ready to use the dynamite, open the box or case with a hardwood wedge and a mallet. Never take more than the day's supply to work, even in warm weather. In cold weather, take only as much as can be kept thawed until it is to be used, unless there are arrangements for keeping it thawed where the blasting is to be done.

Blasting.— When dynamite or other high explosives detonate, the small volume of solid is converted immediately into a volume of gas many times greater than the solid. If the explosive is unconfined there is a great pressure exerted on the holding material, which if not too strong, will be shattered or blown away.

The force of the gases is equal in all directions. If the desire is to blow a boulder or stump into the air the charge is placed below the object. The best shattering is obtained if the explosive is placed in the material to be broken so that the force is exerted on it equally in all directions. This is applicable in blasting soils and blockholing boulders or in splitting stumps.

While the gases exert an equal pressure in all directions, they try to escape by the easiest route or along the line of greatest weakness. If the tamping is omitted or is insufficient, the tendency will be to blow out through the bore hole. If a hole is placed to the side of a stump, the tendency will be to blow out through the more easily lifted soil. The aim should always be to make the easiest way out directly through the material to be moved or shattered.

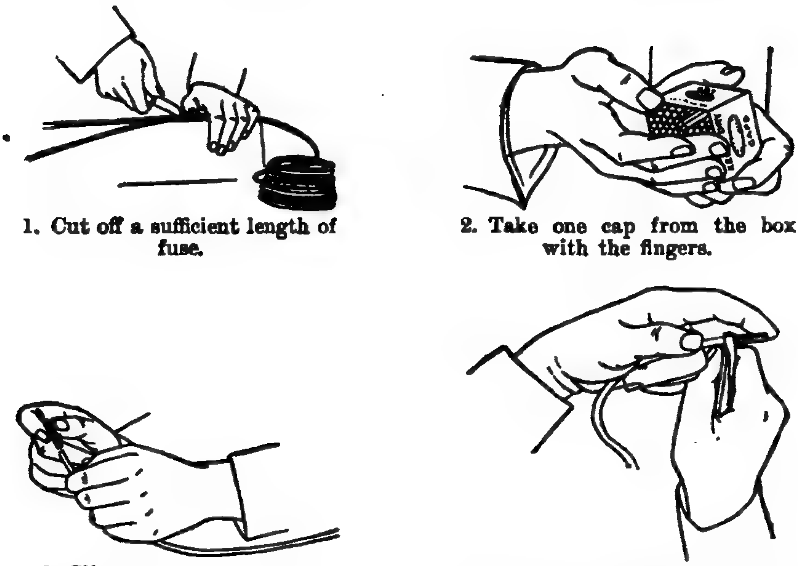
Detonation.— As has already been explained dynamite is fired or "detonated" by means of the shock from a blasting cap or electric blasting cap, either of which is known as a detonator.

In order that the detonation may be complete, or, in other words, that the full strength of the explosives be developed, the detonator should be placed inside the charge, with its closed or "business end" pointed toward the main bulk of the charge.

Priming with cap and fuse.— The act of placing the detonator in the charge is known as "priming" and the cartridge of explosive with the detonator in it is called a "primer."

Attaching the blasting cap to fuse.— Examine your dynamite and see that it is not frozen. Frozen dynamite is hard and rigid, and dangerous to handle; when thawed it is soft. Next

examine your fuse; see that it is not stiff and brittle; if in this condition, it is advisable to warm slightly, and cut the required length from the roll with a sharp knife, hatchet or cap crimper. (The cut should be made squarely across and not diagonally. (1, Fig. 221). Sometimes in the cutting the end becomes flattened, thereby making the end of the fuse too large to enter the blasting cap. When this happens, squeeze the end round with index



1. Cut off a sufficient length of fuse.

2. Take one cap from the box with the fingers.

3. Slip cap on end of fuse.

4. Crimp cap to fuse with cap crimper.

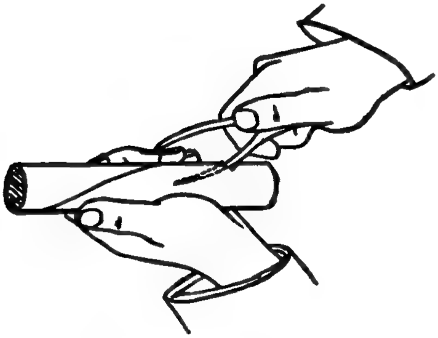
FIG. 221.—Attaching a blasting cap to safety fuse.

finger and thumb. Open the cap box and allow one cap to slide gently out to be grasped in the fingers (2, Fig. 221); but, under no circumstances, pick a cap out of the box with a piece of wire, stick or other hard substance. See that there is no grit or trash in the cap. Slip the end of the fuse gently into the cap until it is against the charge in the bottom (3, Fig. 221). Do not twist the fuse as the friction might cause a premature explosion. Then take the cap crimper and fasten the cap to the fuse with a crimp near the open end of the cap (4, Fig. 221). These operations are not dangerous, but should be done carefully. If the primer is to be used in a wet hole, smear a little hard tallow, soap or similar substance around the top of the cap to insure against water leaking in and ruining the cap before it is fired. Never use oil or light grease as these will penetrate the fuse covering and

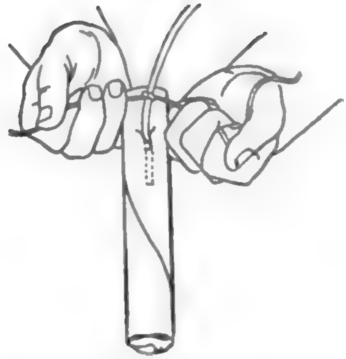
ruin the powder. The cap is then ready to be inserted into the dynamite.

There are two reliable and satisfactory ways of doing this: In the side and in the end. Never lace the fuse through the cartridge when using either method.

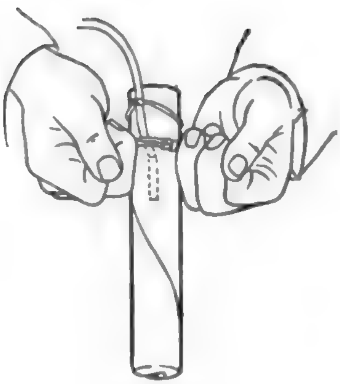
Priming cartridges in the side.—This is done by punching a hole diagonally into the side of the cartridge (1, Fig. 222) near



1. Punch a hole in side of cartridge with handle of cap crimper.



2. Tie cord around fuse.



3. Complete by tying around cartridge.

4. Completed primer ready to load.

FIG. 222.—Priming a cartridge in the side (a highly satisfactory method for most classes of agricultural blasting).

the end and pointing toward the center to a sufficient depth to receive the entire cap. Insert the cap with fuse attached and tie it there with a piece of cord, wrapping it firmly around both the fuse and the cartridge (2, 3 and 4, Fig. 222). The method has the advantage of leaving a good place to place the tamping stick in seating the primer in the hole, but, for small holes, has the

disadvantage of a slight increase in size. This method is the one generally used by agricultural blasters.

Cutting a dynamite cartridge in half.— When small charges are desired, it becomes necessary to cut cartridges in half. This should be done with a sharp knife. Hold the cartridge firmly in one hand and the knife in the other. Giving the cartridge a rotary motion, cut the paper all the way around and then bend the cartridge slightly, when it will come apart just where the paper is cut. Never try to cut a frozen cartridge.

Making bore holes.— The holes made for loading explosives are called "bore holes." These should be prepared before the primers are made. The tools required for making such holes are few and simple, consisting either of a sledge and pointed steel bar or of soil augers. Bore holes in rock, of course, have to be made with rock drills.

Loading.— When the cartridge is primed and the bore hole made, the next thing to do is to load. First try the hole with the tamping stick to see that it is open and will permit the charge being placed at the desired point.

When loading small charges, as when only a full or half cartridge primer is used for subsoiling or tree planting, start the primed cartridge into the bore hole and press it gently into place with the tamping stick. See that it is firmly seated in the bottom of the bore hole.

In pressing a primer into place, do not handle it roughly, as it contains the cap and is, therefore, more sensitive and dangerous than an unprimed cartridge.

When the load is to contain a larger amount of dynamite, press the unprimed cartridges into place in the bottom of the hole first, and place the primer with the cap pointed toward the rest of the charge on top. When the bore hole is dry, and it is desirable to have the charge concentrated in one place, it is a good practice to slit the sides of the cartridges in two or three places and from end to end with a knife so that the dynamite can be compacted into a smaller space. The primer should not be split.

In all classes of agricultural blasting, the charge should be pressed firmly into the bottom of the bore hole so that no air pockets are left, as they weaken the action of the explosives. When bore holes are wet, it is not advisable to slit cartridges.

For most work it is necessary to determine the correct amount of explosives by a few test shots.

Tamping.— Closing the top of the bore hole after the charge

is placed is for the purpose of more closely confining the charge to insure better work and is called "tamping." It should be made as tight as possible so that the gases will not blow out as through the muzzle of a gun.

To guard against danger of prematurely detonating the charge, the first five to eight inches of tamping should not be packed with any considerable force, but should be gently firmed. When this amount of lightly tamped material covers the primer, the rest of the tamping should be made as hard as possible, using the wooden tamping stick in one hand.

Moist clay, free from gravel and clods, makes good tamping material. Free running sand or moist loam is also good. In wet work, when a foot or more of water covers the charge in shallow holes, it will not be necessary to add other tamping, as the water will hold the charge sufficiently tight. Loading and tamping should be done in such a way that no open-air spaces are left.

When using soil for tamping, the hole should be tamped full. Do not allow sharp pebbles or stones to fall in the hole during loading and tamping.

Before beginning tamping, it is well to measure the depth from the surface to the top of the charge so that if the tamping must be removed to get at a misfire, there will be no danger of disturbing the primer. It is a good practice, especially where heavy charges are used, to place two inches of paper or dry leaves immediately over the primer, so that they can be used as a safety marker should the tamping need to be removed for any cause.

Firing.— Exploding the charge is called "firing," and can be done either by means of caps and fuse or by electric blasting caps with a blasting machine. When cap and fuse are used, cut the fuse long enough to reach about three inches out of the bore hole and to enable you to retire to a safe distance. Fuse burns on an average of two feet per minute and a sufficient length should be used to permit of the blaster reaching a safe point before the explosion. When using electric blasting caps, the leading wire should be long enough to enable the one who operates the blasting machine to be outside the danger zone. No blast should be fired until persons, animals and vehicles are well out of range.

When reliable explosives and blasting supplies are used, and the primers properly made and placed, misfires should seldom occur. When using cap and fuse, and a misfire is noted, do not return to examine it at once, as an injured fuse may be burning

slowly and delaying the shot. It is better to wait until the next day, if possible.

When using electric blasting caps, there is no danger of delayed shots and less likelihood of misfires. When one does occur, disconnect the wires from the blasting machine, and it will be safe to return immediately to the blast for investigation. Never connect the wires to the blasting machine until it is time to fire, and guard against a careless person tampering with the machine and leading wire while loading shots.

In selecting a safe place to watch a blast, do not get behind a tree or building, but stand in the open at a safe distance from the blast, so that you can see the flying fragments and dodge any that may come beyond reasonable bounds. Do not have the sun in your eyes, as it may obscure flying missiles.

Obtaining practical instructions before blasting.—To do blasting work successfully, economically and safely, it is very desirable that the blaster should first familiarize himself with approved methods. Sufficient space cannot be spared here for a detailed description of best blasting practice and precautions necessary to be observed in handling dynamite. Our advice, therefore, is to write to a manufacturer of explosives for an instruction booklet before attempting any blasting operation.

CHAPTER XXVII

KEROSENE AND GASOLINE ENGINES ON THE FARM

BY ARNOLD P. YERKES[1]

The tractor.— The introduction of the farm tractor for agricultural operations marked just as distinct a step in human progress as did the substitution of the steam railway for the old stage line, or the development of the automobile and motor truck.

The gas tractor (so called because it derives its power from an internal combustion engine burning a gasified fuel, usually gasoline or kerosene) has entirely eliminated the need of horses for practically all kinds of work on most types of farms.

While it was designed primarily to do the heavy work of plowing, it was only a few years until it had been so perfected as to enable it to do all kinds of field work for which the horse is commonly employed, and, in addition, it is used extensively for belt work, operating stationary machines, for which the horse never was a satisfactory source of power.

Although it has been proved in numerous cases throughout the country that a farm can be operated efficiently and economically by mechanical power alone, it is more common to find a few horses retained for odd jobs even on farms where a tractor is used, largely for the same reasons that caused the old grain cradles to be retained for years after the purchase of a reaper. In such cases, however, the work of plowing is usually performed almost entirely with the tractor, as are also the disking, harrowing and other work of preparing the seed bed. Planting and drilling, being comparatively light work, is in most cases done by horses, although the use of the tractor for these operations is by no means uncommon. Even the work of planting corn, as well as cultivating it and other tilled crops, which is comparatively light work for a team of horses, can be done with entire satisfaction by the combined motor cultivator and planter — the small brother of the gas tractor.

In haying and harvesting of all kinds, the tractor is frequently used to pull one or more mowers, binders, corn harvesters, etc. When a header or harvester-thresher is used, the tractor also

[1] International Harvester Company.

furnishes power to move these machines over the field, although in some cases the power to operate the mechanism is furnished by an auxiliary engine mounted on the machine.

As already mentioned, the tractor is used to furnish power for all kinds of belt work. Such operations on many farms represent nearly fifty per cent of the work for which the tractor will be used. The increasing use of silos makes it necessary to have power to operate the ensilage cutter; wherever small grain is raised there is threshing to be done; on corn belt farms there is always a lot of corn to be shelled, while it is not at all infrequent to find the tractor furnishing power to shred the fodder and husk the ears at the same time. Baling hay and straw, pumping water for irrigation, sawing wood, grinding feed, and a dozen other odd jobs fall to the lot of the mechanical horse.

While the gas tractor naturally is most satisfactory and efficient when used on level land and on soil where a good footing is obtained, it is to-day being used under nearly every farming condition found in the country. Often special attachments are necessary to make it satisfactory for use under such conditions as soft ground, among stones, etc., but practically all these problems have been solved very satisfactorily.

While the principal objection to the early tractors was their heavy depreciation, the later machines have demonstrated that a life at least equal to that of a horse may be expected from them when they are given proper care and attention, particularly with respect to lubrication. It is a well-known fact that nearly all farm machines suffer more from lack of oil than from any other one cause. While the bearings of most farm machines work under comparatively light pressures and do not transmit any great amount of power, in the case of the tractor the reverse is true, and proper lubrication is absolutely essential to satisfactory operation. Furthermore, a careful watch on practically all bearings is a necessity, because a slight looseness here will nearly always cause excessive damage if neglected. Attention to these two items of keeping bearings properly tightened and well lubricated will go a long way toward insuring satisfactory operation of any tractor.

The early tractors were naturally used largely with machines which had been designed for use with horses since no special equipment was available. To-day, however, there is already a rather complete list of specially designed machines for use with tractors, and this is constantly being increased. It goes without saying that a tractor does the most satisfactory work when

used with machines which were designed especially for the purpose. When plows and other implements intended for use with horses were employed it was generally necessary to have someone to operate the various levers. Plows, disks and other implements designed for use with the tractor, however, can be operated by the tractor driver without leaving his seat, and in most cases the work of raising and lowering, or changing the adjustment, is done by the power of the tractor itself.

The gas tractor is destined to revolutionize the agricultural industry within a few years. With further development of the larger sizes as well as in the form of motor cultivators, etc., together with more improved equipment for use with it, the raising of our staple crops in the principal agricultural areas will undoubtedly be carried on more and more by mechanical power.

In the hands of a competent operator the internal combustion engine is an exceedingly reliable source of power. In inexperienced hands, however, unnecessary delays sometimes occur due to slight misadjustments which can be corrected easily and quickly when the causes of the irregular operation are known.

For this reason the average operator will generally find that a condensed trouble chart showing the possible causes of the more common forms of trouble is often of considerable value.

The one given herewith is applicable to any of the ordinary types of gas engines such as are used in tractors, automobiles and for stationary work. This will cover more than ninety per cent of the troubles commonly experienced with internal combustion engines, but, of course, does not include some minor points common only to particular makes because of details of design.

This chart does not cover starting troubles under a separate heading, but nearly all the items under the first two heads, "Loss of Power" and "Misfiring," may also be responsible for difficulty in starting.

Trouble with internal combustion engines.— When trouble is experienced with a gas engine, it is usually a comparatively easy matter to remedy it if the exact cause is located. There are nearly always several different things which might produce any one of the various troubles commonly experienced in operating an engine. Sometimes an operator is apt to jump to a wrong conclusion in attempting to diagnose the trouble. Frequently the exact cause will not be apparent at once, even to an experienced operator. Furthermore, it is difficult to keep in mind at all times the various things which might be producing a certain symptom.

By having at hand a condensed chart showing most of the possible causes of the various irregularities, considerable time will often be saved by using it as a reminder. With all the possible causes in mind, a little reasoning and perhaps a few tests will nearly always enable one to reach the correct conclusion. The chart shown on this page shows the most common causes of engine troubles and it is hoped that gas engine operators may find it of value for reference. It is suggested that it be cut out, pasted on a piece of cardboard and kept in a convenient place for use when needed.

A TROUBLE CHART FOR INTERNAL COMBUSTION ENGINES

CARBON:

Combustion
- Results from incomplete combustion of fuel or lubricating oil which enters the combustion chamber; most often the latter. Oil in combustion chamber is usually due to worn or poorly fitting piston rings, too much oil in crank case, or being fed by oiler.

Fuel
- Too rich a mixture or poor carburetion is usually responsible for carbon formation from unburned fuel. Poor carburetion is often due to the use of a lower grade of fuel than the carburetor can handle properly.

LOSS OF POWER:

Ignition
- Spark occurring too late.
- Spark weak because of partial short circuit or battery becoming exhausted.
- Dirty spark plugs.
- Poor connections.
- Dirty timer.
- Poor or broken wiring in case of magneto.
- Breaker points worn, oily, or out of adjustment.
- Commutator brush dirty or oily.

Fuel
- Mixture too lean or too rich.
- Supply pipe partly clogged.
- Inlet valve not opening sufficiently, due to wear.
- Water in fuel.
- Leaks around intake manifold.

Motor
- Overheating in cylinder or bearings.
- Gummy, inferior or insufficient oil.
- Exhaust pipe partially clogged.
- Governor out of adjustment.
- Lack of compression, which may be due to worn, stuck, or broken piston rings.
- Scored cylinder walls.
- Leaks through and around head joints.
- Valves sticking, worn, pitted, or not seating properly because of dirt.
- In cold weather engine and cooling water too cold.

MISFIRING:

Ignition
- Weak batteries.
- Poor connections.
- Dirty timer.
- Vibrator or breaker points pitted, dirty or poorly adjusted.
- Dirty or cracked plugs, points of plug not properly spaced.
- Make and break points not touching properly.

Fuel
- Mixture too lean or too rich.
- Fuel passage partly clogged.
- Water in fuel.

Motor
- Lack of compression.
- Valves stick or not working properly.

EXPLOSIONS IN EXHAUST PIPE:*

Ignition
- Irregular ignition.
- Poor spark, or very late spark.

Fuel
- Mixture too lean or too rich.

* Often occurs just after starting, due to first charges not firing in cylinder and passing through into exhaust pipe, where burning gases from first few explosions will ignite them.

POUNDING:

Ignition	Spark too early.
Motor	Red-hot carbon deposit in cylinder. Loose bearings. Tight piston, due to lack of oil or lack of cooling water. Hot bearings. Loose flywheel. Very loose piston (piston slap).

BACKFIRING:

Ignition	Spark too late. (If motor backfires and stops, spark may be too far advanced). Short circuit on primary wire. Wires to wrong plugs.
Fuel	Weak mixture. Occasionally too rich mixture.
Motor	Leaky or stuck intake valve. Red-hot carbon deposits. Leaky manifold or carburetor gasket.

OVERHEATING:

Ignition	Spark too late, or very weak.
Fuel	Mixture too rich.
Motor	Insufficient lubrication. Insufficient cooling water. Circulation of cooling water impeded. Pump not working properly. Heavy carbon deposits in cylinder. Water chamber coated from impure water.

IRREGULAR SPEED:

Ignition	Loose connections, or partly broken wire. Vibrator or breaker points pitted, or poorly adjusted.
Fuel	Supply to carburetor irregular. Dirt on needle valve.
Motor	Governor gummy, sticky, out of adjustment or badly worn. Valves sticky.

SMOKE:

Black smoke in exhaust indicates too rich a mixture.
Bluish smoke indicates too much lubricating oil.
Smoke from the crank case or open end of cylinder indicates leak past the piston.
Look for worn rings, rings stuck in grooves, or scoring on cylinder walls.

CHAPTER XXVIII

THE CARE OF TOOLS ON THE FARM

BY EDGAR W. COOLEY[1]

The annual loss to the farmers of the United States from careless use of farm machinery and the neglect of it when not in use foots up a gigantic sum. One of the most important buildings on any farm is the tool-house. It is possible to store farm machinery promiscuously under shed, on the barn floor, in the barn basement, and other places, but the farmer who depends on thus storing his machinery usually leaves it out of doors a good share of the time. There should be a tool house with a place for each machine, and this tool-house should be located so that it is easily accessible, thus making it as easy as possible to get the machinery under cover when not in use. It is no small item to bring machinery in from the field, many times when it should be brought in, and anything done to encourage this good practice is worth while — hence, the value of an easily accessible tool-house. When the location of fields will permit, it is a good farm rule to bring the machine to the tool-house every evening after the day's work, and in some instances it would be wise to bring the tool in at the noon hour, especially if weather is threatening and there is an uncertainty as to whether the tool will be used in the afternoon.

Such tools as the grain binder, the grain drill, and the corn-planter should never be left in the fields or in the open over night unless covered with a waterproof canvas. Too often it is the practice of the farmer to bring his grain binder or wheat drill to the tool shed, unhitch from it and leave it out two or three days before running it into the tool-house. It takes no more time to run the tool under cover at the time it is unhitched than it does a few days later. Not only does great loss of time and machinery result from the neglect of large tools like the grain binder and grain drill but also smaller and less complicated tools, such as the walking plow, peg tooth harrow, and cultivator depreciate rapidly in service-rendering value from being exposed. The cost of time getting the plow to scour or

[1] Expert on farm tools and implements.

brighten after being left in the field through a rainy spell would pay several times for bringing the plow to the tool shed and oiling the mold board while it is yet bright. Without going into detail we offer the following suggestions for the care of farm machinery:

Go over each machine at least two weeks before time to use it, examine every part thoroughly and either replace it or else order the part and have it ready in case a break occurs during the busy season. It is unbusinesslike to take a chance on any weak parts lasting through the year. It is good insurance to have the repair part ready in case the break does occur and in case it does not occur it does no harm to have the part on hand for next year.

Give the machine a complete overhauling and have it ready when it is needed. This overhauling can be done on days when work is not pressing.

Use a good grade of oil and keep the machine thoroughly oiled. Many machines have gone to early ruin from lack of complete lubrication. Remember that as long as there is a film of oil between the working parts there will be no wear on the metal. Study the machine, locate the parts that work rapidly and oil these several times a day. Some of the slower working parts, such as the bull wheel on the binder, needs oiling only once or twice each day. Cover the machine at night, or, better still, back it into the tool-house. Any machine, the wearing parts of which are apt to rust during two or three days' idleness such as the disks of the disk harrow or disk drill, the hoes of the drill or the mold board of a plow should be oiled when the machine is unhitched. This is easily done by using a can of axle grease and a painter's brush. A handy man can oil the mold board of a plow in one minute. A good plower will have a small box of grease and a brush always with him. The time that it takes to oil the disks of a harrow or drill is small indeed compared with the time and energy spent in getting them bright sometimes.

In the fall, after the farm machines have served their purpose for the year, take a little pains in getting them located for the winter. It is well to put blocks under the plow to hold it up off the floor in case it is a concrete or gravel or earthen floor. This helps prevent rust. Be careful that the machinery such as the grain binder, hayrake, mowing machine and grain drill are not stored on a "twist." Careless storing of machinery sometimes bends some part out of shape, resulting in unusual wear on some parts when the machine is put to use.

Make the tool-house as near weatherproof as possible. Building paper and strips or laths are cheaper than machinery. Do not have any leaks in the roof and do not leave any cracks through which rain or snow can blow. The fact that a machine can be left out of doors all winter and still run the next year is no argument against making the tool-house water-proof.

The satisfaction of having tools that will operate smoothly and efficiently is pay enough for giving them care even if there

FIG. 223.—A corn harvester left out in the snow to rust and decay. This is a great loss to the farmer and should be avoided.

were no money or cost involved. The suggestive list of tools necessary for operating a one hundred and fifty-acre farm in Central New York and the estimated first cost will help to bring home to us the importance of caring for this investment in farm equipment. The man who invests such a sum of money in farming equipments can well afford to borrow money to build a tool-house to store them in. The only reason for the short life of good machinery on the average farm is carelessness and neglect.

Machinery to Equip a Farm of 150 Acres in Central New York

One fourteen-inch walking plow.
One hillside plow.
One disk harrow, four-horse size, 10x16.
One peg-tooth harrow, ⅝x⅞, thirty teeth.
One two-row corn planter.
One one-row corn cultivator.
One one-horse cultivator.
One grain drill with fertilizer attachment, two-horse size.
One farm wagon.
One grain binder, six feet, with bundle carrier.
One corn binder, without elevator, with bundle carrier.
One manure spreader, No. 8 Endless.
One side-delivery hay rake.
One mowing machine, five-foot cut.
One tedder, six-fork.
One lime sower.

Other Machines Which Could be Used to Advantage Provided Farmer is Able to Install Them at the Start

One 8-16 tractor, with hitches for working machinery, listed above.
One breaking plow for tractor.
One potato digger.
One silage cutter, right size to be operated with tractor.
One potato planter.

Hay-hoisting equipment might also be included. The cost would depend upon the size and extent of equipment.

Fig. 224.—A poorly kept farm, showing a lack of interest and poor business judgment.

CHAPTER XXIX

THE CARE OF THE HARNESS*

Under ordinary conditions, when harness and leather equipment is constantly exposed to the varying conditions of weather and because of its value and its rapid deterioration under neglect, conscientious care is necessary to insure its long life and serviceability.

For the proper care of all leather equipment, two agents are necessary — one for cleaning and one for oiling. The cleaning agent is castile soap; the oiling agents are Neatsfoot oil or harness soap. The castile soap is a commercial article containing about three per cent of lye, which is necessary to give it the required cleaning power. Its action, however, is merely to free the leather from dirt, sweat and other matter which accumulates in the surface pores or the leather.

Neatsfoot oil has been used for many years, and from experience has been found to be the most satisfactory for oiling the leather; it penetrates the pores and saturates the fibres, making them pliable and elastic. Dry leather is brittle; leather oiled too much will soil everything it comes in contact with, and also it accumulates dirt. The condition to be desired is just enough oil in the leather to make it soft and pliable without so much that it will exude. All animal oils and fats, and most vegetable oils may be used with good results. Mineral oils should never be used for this purpose.

In washing with an alkaline soap, it is impossible to prevent the removal of the surface oil. This tends to leave the surface hard and dry and liable to crack. It is difficult to replace this surface oil without applying an excess, so it has been found necessary to have a different kind of soap. There are various kinds of saddle or harness soaps, most of which contain more or less neutral oil which replaces the surface oil removed in washing.

Cleaning with saddle soap.— All leather equipment must first be wiped off daily or as often as used, with a dampened cloth to remove the mud, dust, etc. It is never cleaned by holding it in water or under a hydrant. Daily wiping will do much to

* Courtesy of the *Dakota-Farmer.*

maintain the appearance of harness, but it is insufficient of itself to properly preserve it. At intervals of from one to four weeks, depending upon circumstances, used harness should be thoroughly cleaned. First, the harness is taken apart, all buckles, loops, straps, etc., removed wherever possible. Then all surface dust and mud is wiped off with a damp (not wet) sponge or cloth. Then a lather is made by moistening the clean sponge in clean water, squeezing it out as nearly dry as possible, and rubbing vigorously upon the castile soap. When a thick, creamy lather is obtained, all pieces are cleaned.

After cleaning the sponge again, make a thick lather as before, but this time with saddle soap; go over each piece again, working the lather well into it, remembering that its action is that of a dressing. After the leather is partially dry, it should be rubbed with a soft cloth to give it a healthy appearance. If the leather is soft and pliable, nothing further is required. Occasionally, however, it is found necessary to apply oil. During the first few months of use, a new set of harness should be given at least two applications of oil each month. Frequent, light applications are of more value than infrequent, heavy ones. Before using new equipment, it should be given a light application.

How to oil leather.— The quantity of oil used should rarely exceed an ounce or two tablespoonfuls for each set of harness. Oil should be applied to the flesh side where practicable, when the leather is clean and still damp, after washing. It should be applied with an oiled rag or cotton waste by long, light, quick strokes, with the endeavor to make a light, even distribution. After oiling, leather should be allowed to stand twenty-four hours, if possible, in a warm, dry place, then rubbed with a dry cloth to remove unabsorbed oil.

Oil is applied on the flesh side because it penetrates more uniformly, and when the leather is dry it will absorb oil like blotting paper, preventing proper distribution. An additional reason for consistent cleaning and oiling lies in the fact that practically all leather contains at least one-tenth of one per cent of sulphuric acid, acquired as a normal product of tannage. This acid, which, if excessive, will in time rot the leather, is neutralized by the alkali of the castile soap, and to a less degree by the oil.

A few cautions to be observed are: To keep the leather clean and off the ground; keep pliable by light applications of oil; use only materials recognized as good; dry all leather in the shade,

never in the sun or close to a stove, radiator or furnace; never use shoe polish to brighten the surface of harness; store leather in a cool, dry place where there is no artificial heat.

To clean such equipment as bits and other metal parts of the harness, no more force should be used than is necessary to remove such dirt, etc., as may be collected. A piece of wood will remove the softened dirt and mud, but no emery paper or other abrasive should be used. There are many good polishing liquids on the market to brighten or polish buckles, etc.

A harness repair outfit.— Although it is commonly considered to be within the province of the saddlers, and consequently is neglected by the farmer, there is no reason why the latter should not make many of his own repairs. There is, of course, such repair work as stuffing the collar, etc., which requires a trained man.

The outfit.— Some of the following tools may not be absolutely essential, but they comprise a fairly complete outfit:

One pair clamps.
One pair pliers, No. 3.
One dozen awls, assorted.
One dozen awl-handles.
One dozen awl-collar needles, assorted.
Two packets needles, Nos. 2 and 4.
One saddler's compass.
One round knife.
One saddler's hammer.
One edge tool, No. 2.
Two tongue punches, Nos. 35 and 37.
Four round punches, Nos. 3, 4, 5 and 6.
One fine saddler's shoulder-crease.
One single-hand crease.
One saddler's palm.

Different materials which are required in renovating harness:

Pitch, per pound.
Resin.
Wax.
Best brown hemp, No. 2, per pound.
Tacks, per packet.
Bridle leather, per side.
Harness leather, per pound.
Collar-check, per yard.
Brown serge.

A small leather apron about four by twelve inches, is required. This is suspended from the waist and hangs over the right thigh. A small S-hook, for holding the hemp whilst making the thread, is also needed. Also a suitable bench should be provided and placed where there is good light.

Requirements of good stitching.— To obtain good stitching it is necessary that:

1. Thread of a kind and strength suited to the nature of the work be selected.
2. The thread be smooth, well-twisted, and well-waxed.
3. The stitches be all drawn equally tight, and made as firm as possible, without cutting the leather.
4. The needles be used in the right way.

5. The right kinds of awls be selected and correctly used.
6. The stitches be made towards the operator.
7. The work be closely and firmly held in the clamps.
8. The stitches be of equal length.
9. The holes be of equal size and angle.

Always have tools sharp, clean and in their proper places. Neatness of equipment means efficiency in work.*

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* New South Wales Department of Agriculture.

CHAPTER XXX

A PRACTICAL FARM REPAIR SHOP[1]

By J. W. Dickerson

Every progressive farmer should have a "Bad Weather Work Shop" on his farm, well lighted, having good ventilation, and equipped with up-to-date machinery and tools.

It is a time and money saver to overhaul and repair the farm equipment. All machines should be kept properly adjusted and properly cared for so that when the call comes for its use, it will be in running order.

Points worth remembering.— Machines, when not in use, should be brought under shelter and all bearings carefully oiled with heavy lubricating oil, and all bright parts painted with a mixture of equal parts of whiting and cup grease, which can easily be removed with gasoline or kerosene; loose nuts tightened; badly worn chain links repaired; bent rods straightened; excessive wear taken up; all parts needing it given two good coats of the paint suited to the wood or metal surface; disk blades, etc., sharpened; harrow teeth and cultivator shovels pointed; scythes and sickles ground; many other things may be done also to put the machines and equipment in condition to work at maximum efficiency at an hour's notice.

Along with this careful overhauling of his machinery the owner also sees that his auxiliary equipment — whiffletrees, singletrees, clevises, log-chains, weed-hooks, rolling colters, ladders, hayracks, shovel boards, wagonbeds, sideboards, tip-top boards, hay forks, pulley block and so on — is fully repaired and painted.

The repair shop is of value to the housewife, for here she may have chair rounds or rockers tightened; table drawers repaired; the cupboard door that has swollen fitted; the screen door repaired; the doors that sag repaired; butcher knives sharpened, and kitchen equipment repaired. She also may have many home-made contrivances that she never before dared to hope for.

Always buy good tools for the shop and keep them in good condition. Keep on hand nails and screws of different sizes. To prevent nails and screws from rusting dip in boiled linseed oil.

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[1] Courtesy of the *Country Gentleman.*

For general repair work on machines, driving in pins, and such operations, the machinist's ball-peen hammer of medium weight is the most satisfactory, while for anvil work the heavier hand hammer is preferable. The heavy sledge comes in handy for heavy hammering and cutting on the anvil and is serviceable in a hundred other ways around the farm. One of the next additions will be a small half-pound hammer for riveting and harness work.

The hardy is set in the square hole in the anvil and is very convenient for light cutting, when the farmer must hold his work and use the hammer himself. For heavier work, when the hired man uses the sledge, the hot and cold cuts are used.

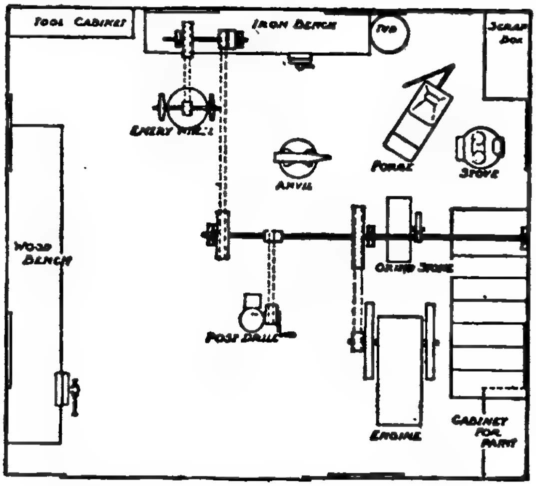

Fig. 225.—Floor plan of the repair shop.

The most expensive part of his tool equipment is the set of screw-cut cutting taps and dies, but it is also very valuable. Renewing a stripped or damaged thread on a bolt or nut is a simple operation and need keep the piece of equipment out of service but a very short time. A supply of bolts, nuts, washers, screws, rods, bars, shafting and tubing may often be secured by tearing apart old machinery.

Soldering outfit pays.— Three important things to remember:

1. Have surface to be repaired bright and clean.
2. Use plenty of zinc chlorid flux.
3. Have soldering iron just hot enough to make the sal ammoniac smoke freely.

An outfit for harness repairing and shoe mending is worth considering.

For light, hasty repair work the light riveting machine using hollow steel rivets is quite satisfactory, while the belt punch and copper rivets take care of heavier work. The iron repair-stand with the iron lasts is very convenient for rough half-sole work on work shoes where looks are not very important.

Pipe wrenches, dies, vise and cutter should be on hand if the buildings and barns are piped for water.

The gasoline engine is of the horizontal, hopper-cooled type, as this is usually the cheapest and most convenient in the four-horse-power size.

The engine is fastened to the floor by means of a two-by-four-inch crosspiece at each end, held by a five-eighths-inch lag-screw

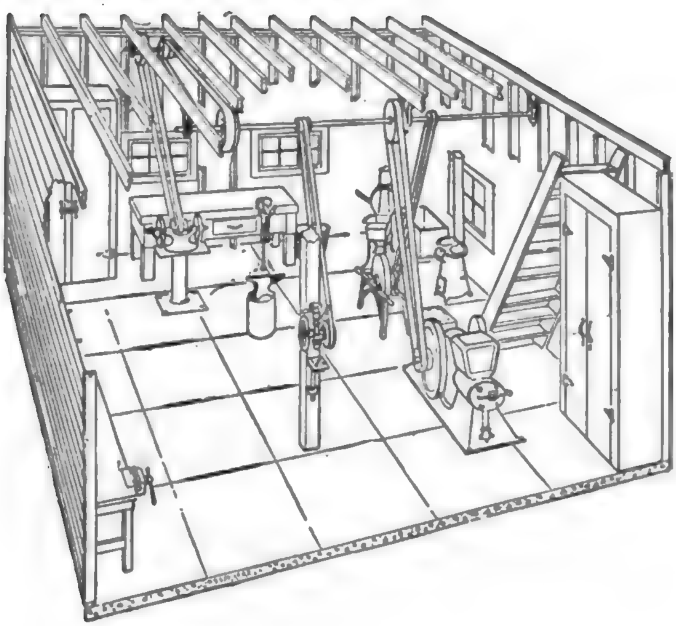

Fig. 226.—Perspective drawing showing the equipment

long enough to extend about three and a half inches into the concrete. The engine was set as shown, partly to get cylinder-head, valves and carburetor next to the wall, where there is plenty of light for adjustments, and partly to have the main drive belt so that the upper side is the slack or loose side and thus secure a better grip on each pulley.

The post-drill faces away from the main shaft, so that belt coming fròm behind will be out of the way of the operator, and has clear space enough that holes may be bored in a binder cutter-bar or other long piece. It is fastened firmly to a six-by-six-inch wooden beam set into the concrete at the bottom and bolted to a floor joist at the top, and is equipped with both hand crank and belt drive with fast and loose pulley.

It is found best to have the main shafting run near the center of the shop, as this makes it available for running machines at either side. One twelve-foot section of one-and-a-half-inch cold-rolled steel shafting is sufficient for the machines shown and for driving any temporary machines that may be desired, such as a disk sharpener. For this reason the shaft is extended farther over the repair floor than would otherwise be necessary. Three eight-inch, four-point, adjustable, wick-oiling drop-hangers give plenty of rigidity, and when placed on the lower side of the two-by-eight-inch joists give plenty of clearance for any pulleys that are likely to be used. Short hangers are preferred, as they cut down the amount of vibration.

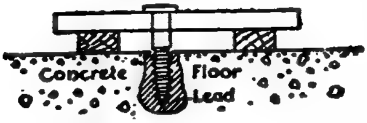

FIG. 227.—Method of fastening

One countershaft is required for the emery wheel, partly to secure the desired change in speed, partly to make a more convenient method of throwing in and out of operation, and partly to bring the belt down out of way of the operator.

LIST OF EQUIPMENTS FOR REPAIR SHOP

No 1 — Carpenter

One bit-stock or brace.
Eight auger bits, 3/16, ¼, 5/16, ⅜, 7/16, ½, ⅝, ¾ inch.
One claw hammer, 1¼ pound.
One carpenter's square.
One try-square, 8-inch.
One marking gauge.
One ripsaw, 26-inch.
One handsaw, 26-inch.
One keyhole saw.
Nails and screws.
One jack plane, 14-inch.
One smoothing plane, 8-inch.
Three firmer chisels, ¼, ½, ¾ inch.
One level, 25-inch.
One draw knife, 12-inch.
One dividers, 8-inch.
One wood rasp, 14-inch.
One screw driver, 10-inch.
One screw driver, 6-inch.
One wood bench and vise.

No. 2 — Blacksmith

One blacksmith sledge, 10-pound.
One anvil hand hammer, 3-pound.
One machinist's ball peen hammer, 1½-pound.
Two cold chisels, ½ and ¾-inch.
Five punches, 1/16, ⅛, 3/16, ¼, ⅜-inch.
One center punch.
One adjustable hacksaw frame.
One dozen hacksaw blades.
Twelve twist drills, 1/16, 3/32, ⅛, 5/32, 3/16, 7/32, ¼, 5/16, ⅜, 7/16, ½, ⅝-inch.
Six assorted files with handles.
One screw cutting outfit consisting of two stocks and tap-wrench, and 7 sizes taps and adjustable dies, ¼, 5/16, ⅜, 7/16, ½, ⅝, ¾-inch.
One straight hardy, 1-inch.
One cold cut, 1⅜-inch.
One hot cut, 1⅜-inch.
One straight lip tongs.
Two bolt tongs, ⅜ and ⅞-inch.
One forge with hand blower.
One anvil, steel-faced, 100-pound.
One iron bench and vise.

No. 3—Soldering Tools and Materials

One tin snips.
One square-pointed soldering copper, 1½-pound.
One bar half-and-half solder.
Large crystal sal-ammoniac.
Commercially pure hydrochloric acid.
Powdered rosin.

LIST OF EQUIPMENTS FOR REPAIR SHOP — *Continued*

No. 4 — HARNESS REPAIR TOOLS AND MATERIALS

One hand belt punch, 4 sizes.
One hollow drive punch.
One belt awl.
One coil belt-lace wire.
One bunch cut laces, ¼-inch.
One box copper rivets and burrs, assorted.
One lever riveting machine and box hollow steel rivets, needles, wax, thread.
Iron repair stand with three lasts.

No. 5 — MISCELLANEOUS REPAIR TOOLS

One monkey wrench, 12-inch.
One monkey wrench, 8-inch.
Five double-end S wrenches.
One Button's wire cutting plier, 10-inch.
One pipe-threading outfit, with pipe-stock and 6 adjustable dies for ¼, ⅜, ½, ¾, 1, 1¼-inch pipe.
One single-wheel pipe cutter.
Two Stillson pipe wrenches, 10 and 14-inch.
One open-hinge pipe vise.
One pinch-point steel crowbar.
One trowel for concrete work, 10-inch.
One pointing trowel.
One sidewalk edger.
One sidewalk groover.
One putty knife.
One glass cutter.
One melting ladle for Babbitting.
Two and one-half pounds Babbitt metal.
Assorted paint brushes.

No. 6 — BILL OF MATERIALS FOR HOUSE

Eight joists 2"x8"x16' No. 1 yellow pine	131	752 ft.
Twenty-two rafters 2"x4"x14' No. 1 yellow pine	205	
Two sills 2"x6"x16' No. 1 yellow pine	32	
One sill 2"x6"x18' No. 1 yellow pine	18	
Two plates 2"x4"x16' No. 1 yellow pine	22	
Two plates 2"x4"x18' No. 1 yellow pine	24	
Forty studs 2"x4"x12' No. 1 yellow pine	320	

Flooring, 360 feet.
Sheathing, 400 feet.
Five and one-half inch drop siding, 1,180 feet.
Good cedar shingles, 5,500.
Nine barn sash windows, 24x42 inches.
Hardware and paper.
Paint, 1,000 square feet, about 5 gallons.
Concrete for foundation, 51 cubic feet.
Concrete floor, 285 square feet.

No. 7 — MACHINERY

	Revolutions per minute
Gasoline engine, 4 horse power, with 6"x4" pulley	425
Emery wheel, 12-inch, with floor stand and 4 wheels	1800
Grindstone, 2½"x28", with belt pulley and treadle	70
Post drill press	84
Countershaft for emery wheel	770
Main shafting	210
Pulleys and hangers.	
Belting.	

CHAPTER XXXI

HOW TO PROLONG THE LIFE OF FENCE POSTS[1]

The chief requirement in a wood for a fence post is durability. For this reason cedar, white oak, and locust have long been the principal trees used. Although formerly plentiful over large portions of the country, these trees are now in many sections becoming too scarce and high-priced to be used for this purpose. Substitutes, either in the form of iron, reënforced concrete, or of the less durable woods, will soon have to take their place. It is doubtful whether iron or reënforced concrete will ever come into common use for fence posts, because such posts are too expensive. Nearly every wood lot, however, contains trees that are not now utilized to any extent for fence posts, because their woods are not durable in contact with the soil, such as maple, birch, beech, cottonwood, willow, hickory, elm, etc. Fortunately, such woods can be made durable at small expense, by a preservative treatment and can be utilized in the place of the more durable woods. Posts that ordinarily last but three or four years in the ground, can be made to last over twenty years by preserving the wood from decay.

Simple methods of prolonging the life of fence posts.— Any method by which wood can be kept dry or that will tend to prevent the entrance of the fungus plant (causing decay), will prolong the life of fence posts. Piling stones, ashes, or gravel about the base, or setting the post in cement, or concrete, will help to drain away the moisture and will prevent the growth of weeds, which keep the air from circulating freely around the post. Thoroughly seasoned posts will last much longer than those that are set green. Good results have been obtained by charring the ends of the posts over an open fire. The posts must be thoroughly seasoned to prevent splitting or checking, and the charring must extend at least six inches above the surface of the ground when the post is set. Painting the surface of the post, or coating with some preservative substance like tar, petroleum or creosote, will help to keep out the moisture and will also tend to prevent the entrance of fungi. To be effective, this "brush

[1] By permission of Missouri Agri. Exp. Sta.

treatment," as it is called, should only be applied to thoroughly seasoned posts. Where creosote or a similar preservative is used, it should be applied hot and at least two coats given. One of the defects of a brush, or surface treatment, is that it is difficult to get the preservative into all the cracks and checks. This can be overcome by dipping the posts in the hot preservative. At best, surface coatings are not durable. They are easily broken or worn off, exposing the wood to fungi and admitting moisture to the interior of the post.

How to preserve fence posts by the use of creosote.— The most effective method of preserving fence posts is to thoroughly impregnate the outer layer of the wood with some preservative substance that will poison the wood and deprive the fungus plant of its food. Many substances have been used for this purpose, but the cheapest and most effective is creosote, or dead oil of coal tar, formed as a by-product in the manufacture of coal gas. It is not only poisonous to the fungus plant, but, being an oil, it also tends to exclude moisture from the wood. Most of the high-priced, patented preservatives have this substance as their base.

The treatment is best carried out by the so-called "open tank method." Thoroughly seasoned posts are heated for several hours in hot creosote, and then allowed to cool down in cold creosote. When the posts are heated in hot creosote, the high temperature causes the air and water in the wood to expand, so that a portion of this air and water is forced out. When the posts are then placed in cold creosote, the air and water left in the wood contract, forming a partial vacuum; and the creosote is forced into the wood by atmospheric pressure, to take the place of the air and water that have been forced out. This forms a shell of creosoted wood from one-eighth of an inch to two inches in thickness around the post, that effectively excludes moisture and prevents the entrance of fungi.

How to apply the treatment.— Where a large number of posts are to be treated, it can be done more quickly and economically by using two tanks. The posts are heated for several hours in boiling hot creosote in the heating tank, and then immediately transferred to the second tank to cool for about an equal length of time, in cold creosote. But for treating a few posts for farm use, the single tank method is advised. In this case, the posts are allowed to cool down in the tank in which they were heated. As good results can be obtained by the use of one tank as with two.

The simplest form of treating tank would consist of an iron

tank four feet high and about three feet in diameter, set up over a brick fireplace with a stovepipe smoke stack. Such an outfit will cost about fifteen to twenty dollars. Often an old iron boiler can be found that will answer the purpose. A galvanized iron tank has usually too thin a bottom to set up over an open fire. Such a tank, however, can be utilized and heated by means of a three-inch U tube. In this case, since the creosote is very inflammable, it should be shielded from the open fire. In either case, a false bottom should be placed in the tank for the posts to rest upon.

Preparation of the posts for treatment.— The posts should be thoroughly seasoned before treatment, as the presence of much water in the wood tends to prevent the entrance of the creosote. Ordinarily, posts loosely piled will season sufficiently in from five to seven weeks. All the bark should be removed, especially the papery inner bark, as it prevents the creosote from entering the wood. Usually only about forty inches of the lower end of the post is treated. This will bring the treated portion of the post six to eight inches above the surface of the ground when the posts are set. It is at the surface of the ground where the fastest decay takes place. Unless the wood is very perishable, it is not usual to treat the tops of the posts, but it can be easily done by inverting the post in the tank after one end has been treated. Merely dipping the tops in the hot creosote will have a favorable effect. When the tops are not to be treated, it is well to cut them off obliquely, so as to shed the rain.

Where posts are to be given a preservative treatment, it is possible to select a much smaller post than is generally used. Large posts are selected for fence posts, because they will last longer than small ones before decay sets in. A fence post of five inches average diameter is large enough and strong enough for the line posts, and is the best size for the preservative treatment. Round posts are preferable to split posts, because hardwood, except in the cases of cottonwood and sycamore, does not absorb the creosote readily.

Carrying out the treatment in a single tank.— Creosote which at ordinary temperature is not a liquid, should be heated in the tank to about 220 degrees F., or just above the boiling point. A higher temperature will tend to weaken the wood and a large amount of the creosote will be evaporated. The tank should then be filled with fence posts. Sufficient creosote should be used to cover at least the lower forty inches of the posts. After heating for a couple of hours, the fire should be withdrawn

and the posts left in the creosote until they have cooled down. The posts will then be treated.

Two runs of posts can easily be treated in a day on the farm without interfering with the regular work. The tank can be filled with posts in the morning and a fire built to last about two hours before burning out. The posts after being heated, will cool down during the day, and by night will be treated. A new run of posts can be put in, heated as before for two hours, and allowed to cool down over night. In cool weather the tank will cool down fast enough so that it will be possible to start a new run at noon. In this way, three runs of fifteen to twenty posts each can be treated without much effort each day.

CHAPTER XXXII

ROADS[1]

The grade is the most important factor to be considered in the location of roads. Steep grades should always be avoided, if possible. They become covered at times with coating of ice or slippery soil, making them very difficult to ascend with loaded vehicles as well as dangerous to descend. They allow water to rush down at such a rate as to wash great gaps alongside or to carry the surfacing material away. As the grade increases in steepness the load has to be diminished in proportion or more horses or power attached. If a horse can pull on a level one thousand pounds, on a rise of:

1 foot in—	POUNDS
100 feet with the same effort he draws..................	900
50 feet with the same effort he draws..................	810
44 feet with the same effort he draws..................	750
40 feet with the same effort he draws..................	720
30 feet with the same effort he draws..................	640
25 feet with the same effort he draws..................	540
24 feet with the same effort he draws..................	500
20 feet with the same effort he draws..................	400
10 feet with the same effort he draws..................	250

Drainage.— An essential feature of a good road is good drainage, and the principles of good drainage remain substantially the same whether the road be constructed of earth, gravel, shells, stones, or asphalt. The first demand of good drainage is to attend to the shape of road surface. This must be "crowned," or rounded up toward the center, so that there may be a fall from the center to the sides, thus compelling the water to flow rapidly from the surface into the gutters which should be constructed on one or both sides, and from there in turn be discharged into larger and more open channels. Furthermore, it is necessary that no water be allowed to flow across a roadway; culverts, tile, stone, or box drains should be provided for that purpose.

In addition to being well covered and drained, the surface should be kept as smooth as possible; that is, free from ruts, wheel tracks, holes, or hollows. When water is allowed to stand on a road the holes and ruts rapidly increase in number and size; wagon after wagon sinks deeper and deeper, until the road finally becomes utterly bad.

[1] Courtesy of Doubleday, Page and Company.

The wearing surface of a road must be in effect a roof; that is, the section in the middle should be the highest part and the traveled roadway should be made as impervious to water as possible, so that it will flow freely and quickly into the gutters or ditches alongside. Where the road is constructed on a grade or hill the slope from the center to the sides should be slightly steeper than that on the level road. Every wheel track on an inclined roadway becomes a channel for carrying down the water, and unless the curvature is sufficient these tracks are quickly deepened into water courses which cut into and sometimes destroy the best improved road.

Water breaks and side ditches.— In order to prevent the washing out of earth roads on hills it sometimes becomes necessary to construct water breaks; that is, broad shallow ditches arranged so as to catch the surface water and carry it each way into the side ditches. Such ditches retard traffic to a certain extent, and often result in overturning vehicles; consequently they should never be used until all other means have failed to cause the water to flow into the side channels; neither should they be allowed to cross the entire width of the road diagonally but should be constructed in the shape of the letter V. This arrangement permits teams following the middle of the road to cross the ditch squarely and thus avoid the danger of overturning. These ditches should not be deeper than are absolutely necessary to throw the water off the surface, and the part in the center should be the shallowest.

Where the road is built on a grade some provision should be made to prevent the wash of the gutters into great, deep gullies. This can be done by paving the bottom and sides of the gutters with brick, river rocks, or field stones. In order to make the flow in such side ditches as small as possible, it is advisable to construct outlets into the adjacent fields or to lay underground pipes or tile drains with openings into the ditches at frequent intervals.

Subdrainage.— In order to have a good road it is just as necessary that water should not be allowed to attack the substructure from below as that it should not be permitted to percolate through it from above. Under drains are not expensive. On the contrary, they are cheap and easily made, and if made in a substantial way, and according to the rules of common sense, a good under drain will last for ages. Slim fagots of wood bound together and laid lengthwise at the bottom of a carefully graded drain ditch will answer fairly well if stone or drain tile can not

be had, and will be of infinite benefit to a dirt road laid on springy soils.

Subdrains should be carefully graded with a level at the bottom to a depth of about four feet, and should have a continuous fall throughout their entire length of at least six inches for each one hundred feet in length. If tile drains cannot be had, large, flat stones may be carefully placed so as to form a clear open passage at the bottom for the flow of the water. The ditch should then be half-filled with rough field stones, and on these a layer of smaller stones or gravel, and a layer of sod, hay, gravel, cinders, or straw, or, if none of these can be had, of soil. If field stones or drain tile cannot be procured, satisfactory results may be attained by the use of logs and brush.

Gravel roads.— Where beds of good gravel are available this is the simplest, cheapest, and most effective method of improving country roads. Inferior qualities of gravel can sometimes be used for foundations; but where it becomes necessary to employ such material even for that purpose it is well to mix just enough sandy or clayey loam to bind it firmly together. For the wearing surface or the top layer the pebbles should, if possible, be comparatively clean, hard, angular, and tough, so that they will readily consolidate and will not be easily pulverized by the impact of traffic into dust and mud. They should be coarse, varying in size from half an inch to an inch and one-half.

Blue gravel and bank gravel.— Where blue gravel or hardpan and clean bank gravel are procurable, a good road may be made by mixing the two together. Pit gravel or gravel dug from the earth as a rule contains too much earthy matter. This may, however, be removed by sifting.

The best gravel for road-building stands perpendicular in the bank; that is, when the pit has been opened up the remainder stands compact and firm and cannot be dislodged except by use of the pick, and when it gives way falls in great chunks or solid masses.

Stone roads.— The practice of using too soft, too brittle, or rotten material on roads cannot be too severely condemned. Some people seem to think that if a stone quarries easily, breaks easily, and packs readily, it is the very best stone for road building. This practice, together with that of placing the material on unimproved foundations and leaving it thus for traffic to consolidate, has done a great deal to destroy the confidence of many people in stone roads. There is no reason in the world why a road should not last for ages if it is built of good material

and kept in proper repair. If this is not done, the money spent is more than wasted. It is more economical, as a rule, to bring good materials a long distance by rail or water than to employ inferior ones procured close at hand.

The durability of roads depends largely upon the power of the materials of which they are composed to resist those natural and artificial forces which are constantly acting to destroy them. The fragments of which they are constructed are liable to be attacked in cold climate by frost, and in all climates by water and wind. If composed of stone or gravel, the particles are constantly grinding against each other and being exposed to the impact of the tires of vehicles and the feet of animals. Atmospheric agencies are also at work decomposing and disintegrating the material. It is obviously necessary, therefore, that great care be exercised in selecting for the surfacing of roads those stones which are less liable to be destroyed or decomposed by these physical, dynamical and chemical forces.

Useful stones for road-building.— Siliceous materials, those composed of flint or quartz, although hard, are brittle and deficient in toughness. Granite is not desirable because it is composed of three materials of different natures, viz., quartz, feldspar, and mica, the first of which is brittle, the second liable to decompose rapidly, and the third laminable or of a scaly or layerlike nature. Some granites which contain hornblende instead of feldspar are desirable. The darker the variety the better. Gneiss, which is composed of quartz, feldspar, and mica, more or less distinctly slatey, is inferior to granite. Mica-slate stones are altogether useless. The agrillaceous slates or clayey slates make a smooth surface, but one which is easily destroyed when wet. The sandstones are utterly useless for road building. The tougher limestones are very good, but the softer ones, though they bind and make a smooth surface very quickly, are too weak for heavy loads; they wear, wash, and blow away very rapidly.

The materials employed for surfacing roads should be both hard and tough, and should possess by all means cementing and recementing qualities. For the Southern States, where there are no frosts to contend with, the best qualities of limestone are considered quite satisfactory so far as the cementing and recementing qualities are concerned, but in most cases roads built of this class of material do not stand the wear and tear of traffic like those built of trap rock, and when exposed to the severe Northern winters such material disintegrates very rapidly. In

fact, trap rock, "nigger heads," technically known as diabase, and diorites, are considered by most road engineers of long experience to be the very best stones for road building.

Macadam construction.—The macadam road consists of a mass of angular fragments of rock deposited usually in layers upon the roadbed or prepared foundation and consolidated to a smooth, hard surface produced by the passage of vehicles or by use of a road roller. The thickness of this crust varies with the soil, the nature of the stone used, and the amount of traffic which the road is expected to have. It should be so thick that the greatest load will not affect the foundation. The weight usually comes upon a very small part of the surface, but is spread over a large area of the foundation, and the thicker the crust the more uniformly will the load be distributed over the foundation.

Telford construction.—The character of the foundation should never take the place of proper drainage. The advisability of underground or subdrainage should always be carefully considered where the road is liable to be attacked from beneath by water. In most cases good subdrains will so dry the foundation out that the macadam construction can be resorted to. Sometimes, however, thorough drainage is difficult or doubtful, and in such cases it is desirable to adopt some heavy construction like the telford; and, furthermore, the difficulty of procuring perfectly solid and reliable roadbeds in many places is often overcome by the use of this system.

In making a telford road the surface for the foundation is prepared in the same manner as for a macadam road. A layer of broken stone is then placed on the roadbed from five to eight inches in depth, depending upon the thickness to be given the finished road. As a rule this foundation should form about two-thirds of the total thickness of the material. The stone used for the first layer may vary in thickness from two to four inches and in length from eight to twelve inches. The thickness of the upper edges of the stones should not exceed four inches. They are set by hand on their broadest edges lengthwise across the road, breaking joints as much as possible. All projecting points are then broken off and the interstices or cracks filled with stone chips, and the whole structure wedged and consolidated into a solid and complete pavement. Upon this pavement layers of broken stones are spread and treated as for a macadam road.

Dirt roads on the farm.—An ideal, hard surface road is a good thing to have. But most of our roads for a long time to come will be dirt highways. This being the case, we may spend time

to advantage in learning what dirt roads are and how to maintain them.

A dirt road should be a slightly rounding surface of earth which has been packed by traffic and other means to make it hard and smooth. It is comparatively easy to make a dirt road, but it is not so easy to maintain a dirt road, for this requires patience and persistence. We are too apt to want to finish a thing and be done with it. We are never done with a dirt road, if we are to maintain it properly. But this does not mean that it is a hard task. A little intelligence and attention occasionally at the right time, is all that is required. The only tool necessary is the road drag, a rake and a shovel.

The dressing of the road by the drag maintains the contour. With wear, the road tends to flatten, and this gives a surface which will hold water. The road must be well drained, for wherever water stands upon it, it becomes softened and ruts deeply under traffic.

The right use of the road drag keeps the road in the form of a watershed. The drag should be used very soon after each rain which soaks the roadway sufficiently so that ruts develop. The time to use it is while the soil is still plastic, but does not stick to the drag.

The following instructions come from the experience of men who made a success in dragging roads:

1. Drive the team at a walk.
2. Ride on the drag to give it weight.
3. Begin on one side of the road and return on the other.
4. Drag the road as soon after every rain as possible, but not while the earth will stick to the drag. There is a time when it is just right.
5. Do not drag a dry road, as the additional dust created will either blow away or form mud with the first rain.
6. The length of the chain regulates the hold taken on the earth.
7. Making the chain longer is equivalent to putting weight on the drag. If the drag is too heavy, shorten the chain.
8. To move much earth or cut small weeds, hitch close to the ditch end of a drag, and stand as near as possible to that end of the front plank or cutting edge.
9. On a soft spot, stand on the front end of the drag.
10. If the drag clogs with straw, sod or mud, put your weight as far as possible on the end away from the ditch.
11. To drop earth in a low place, step as quickly as possible from the ditch end to the opposite end of the drag.

CHAPTER XXXIII

BENEFITS OF THE FEDERAL FARM LOAN SYSTEM

BY JAMES B. NORMAN, M.A.[1]

The Federal Farm Loan Act went into effect on July 17, 1916, the day it was signed by the President. The primary object of the law was to provide capital for agricultural development. This money was to be loaned to farmers for productive purposes at a low and uniform rate of interest. In order to make these loans two kinds of land banks were authorized. One is known as Federal land banks and the other as Joint Stock land banks. These banks make first mortgage loans on farms in all parts of the United States.

Improvement of farm mortgage conditions.— One of the first benefits derived from this Act is the improvement of the terms and conditions of loans. Before the Act was passed farmers had great difficulty in procuring credit except under very harsh terms and conditions. When a farmer mortgaged his farm, it was usually at a high rate of interest, with commission charges of at least one or two per cent, the mortgage was generally made to run not longer than five years, and it was expected that the mortgage would be paid in full when due.

These were burdensome and dangerous conditions. The farmer had to struggle hard during the period of his loan to pay the interest on his debt and keep his household running. If he were unable to pay off his mortgage when it became due and he was fortunate enough to get it renewed, it was only by the payment of an additional commission which increased his burden. But if he had fallen into the hands of a modern Shylock, he was under constant dread of losing his farm and all he possessed. In those days borrowing money on mortgage by the farmer was a gamble with financial slavery or bankruptcy and with the prospect that the farmer would play a losing game.

All these conditions have been changed by the new Federal farm loan system. The interest rate cannot exceed six per cent and is uniform all over the United States; the farmer who borrows has no commission to pay; the charges for appraising a

[1] Assistant Secretary, Federal Farm Loan Board.

farm, searching and recording a title, making out papers, and other incidental costs of procuring a mortgage loan are only what they actually cost the land bank making the loan; and, lastly, the farmer has an easy method of repaying his loan by means of small annual or semi-annual installments. In general, these are the most important benefits to farmers who mortgage their farms under the Federal farm loan system.

The method of repaying a loan is unique. It is called "amortization"— that is, the debt is paid off a little each year. This plan works wonders for the farmer who is in debt. It relieves his mind, for the fear of foreclosure does not haunt him; and it lightens the drain on his purse, for it reduces the amount of interest he has to pay. This benefit alone is worth all the cost of establishing this new system of farm mortgage credit.

Three methods of borrowing money.— The law provides three ways of enabling a farmer to get a loan:

1. If a farmer wants to borrow money from a Federal land bank, he must do so either by joining a national farm loan association or through an agent. These associations are organized with not less than ten members and they operate in a limited territory designated by their charter which is granted by the Federal Farm Loan Board. The limits of loans that can be borrowed through an association are from $100 to $10,000. Up to October 1, 1919, there had been 3,953 national farm loan associations organized in the United States and they had made loans to 100,412 farmers to the amount of $261,175,346.

2. In some localities where associations are not organized, the Federal land banks may appoint agents through which loans can be made to individual farmers. An agent must be a State-chartered bank, trust company, mortgage company, or savings bank. Up to the present time only the Federal Land Bank of St. Paul has made loans to farmers through agents. These agents make loans in the district which includes the States of Michigan, Wisconsin, Minnesota and North Dakota.

3. If a farmer prefers he may procure a loan of a joint-stock land bank. Up to October 1, 1919, this class of land bank had made loans to farmers to the amount of $41,787,360. The limits of loans made by these banks range from $100 to $50,000.

There are twelve Federal land banks and twenty-seven joint-stock land banks in operation in different parts of the United States. At the rate these banks are making loans it will not be many years before their benefits will be extended to farmers all over this country.

A farmer who borrows through an agent or an association pays five and one-half per cent interest, but he has to subscribe for stock in the Federal land bank to the amount of five per cent of his loan. It is expected, however, that this stock will draw dividends at six per cent, or one-half per cent more than he pays out as interest. This is the result of coöperation, for the national farm loan associations and the Federal land banks form the coöperative part of this system. Some of the Federal land banks have already paid dividends to their stockholders, and others will soon be in financial condition to do so.

But a farmer who borrows of a joint-stock land bank pays six per cent interest. He does not, however, have to subscribe for stock, but receives the entire amount of his loan. On the whole, therefore, the benefits derived from borrowing of either kind of land bank are about the same, for both are under strict Government supervision and make long-time loans, ranging from five to forty years, on the amortization plan of repayment. Nearly all the land banks now require an annual amortizement of about one per cent of the loan, which will repay it in about thirty-five years.

Benefits to rural communities.— But the benefits of the Federal farm loan system are not confined to farmers. The Act provides that loans may be expended for various productive purposes, including the purchase of equipment, the making of improvements, and the construction of buildings. This means, as a rule, that every borrower has cash to expend at country stores for lumber, cement, wire for fencing, tile for drainage, lime, implements, machinery, improved seed, and a hundred other things which a farmer needs to make his farm more productive. In each case the country merchant has a larger volume of business and gets paid in cash. Thus the farm loan act is serving rural communities by sowing its benefits broadcast among merchants and the social life of such communities has risen thereby to a higher plane.

And what is true of merchants is true also of rural bankers. If a farmer spends his larger income at his country store, the merchant has more business to transact at his local bank, and the latter does a larger volume of business. If a farmer has a surplus, he is able to run a savings or checking account at the bank. These are results actually achieved by this system. Local country banks are reaping the benefits not only when the funds first reach the national farm loan associations, but also will con-

tinue to profit thereby so long as the system brings increased prosperity to the farmers who use it.

Reduces the high cost of living.— But, lastly, the farm loan system may be expected to reduce the high cost of living, since it encourages agricultural development by making loans at a low rate of interest and on easy terms of repayment. This means better livestock, more modern buildings, improved machinery, more fertilizers, and better seeds. The results have been larger crops and larger incomes to borrowers. When the full effects of the system have been felt in a few years, higher grades and larger quantities of farm products will reach the consumer's door at cheaper prices than at present.

The credit furnished farmers under the conditions named above should certainly reduce the price of farm products. For since farmers can produce more goods with less labor and at a less cost, because their business has the use of capital at a lower cost, they can sell their produce cheaper than formerly and still make greater profits. While this will mean no less profit to middlemen, it ought to mean a lowering of the cost of living in cities. In this way producers, distributors and consumers of farm products will be benefited.

The Federal farm loan system, therefore, has a broad field of service. Its benefits are by no means confined to farmers or rural communities, but will extend into every home in the land. During the two-and-a-half years of its existence the system has met with wonderful success and it now has the loyal support of all those who have their country's welfare at heart.

Farmers who are interested in this helpful system of farm mortgage credit should write for free circulars to the Federal Farm Loan Bureau, Washington, D. C.

CHAPTER XXXIV

THE FARM RECORD

BY HIRAM T. SCOVILL, A.B., C.P.A.[1]

Necessity of keeping accounts.—"[2]Briefly stated, the object in keeping books of account is to furnish the essential facts from which one can find the financial condition of the business over a given period of time.

"[2]All data should be collected with a definite end in view.

"[2]The farmer desires to make as much money as he can from the time he puts in and the investment he has made. A desire to make money is usually not sufficient. The desire must be backed up by action. The action should be directed along proper channels. The proper channels can be determined very largely by an intelligent perusal and interpretation of the accounts properly kept with the aid of cost records.

"[2]The assertion that farmers are making large profits is erroneous. They are living on the earnings of their investment and not on the real profits of the farm.

"[2]The ledger account is the starting point for all analyses and comparisons of results."

Keeping the accounts must precede the interpretation. Keeping account of one's business affairs means the recording of events in a systematic way as they arise. The systematic method in use all over the country by commercial and industrial concerns is desirable but not absolutely necessary on the farm. It is desirable because (1) it enables one to find readily and accurately the reason for the specific amount of loss or gain, (2) it permits one to prove the work and thus avoid errors in recording, (3) it affords an excellent opportunity for one to check up on one's assets and liabilities, and (4) it makes it possible for one's heirs or successors to find out what the financial situation is when occasion demands.

Methods.— All records may be kept in one account book with ledger ruling of about two hundred and fifty to three hundred pages. Reserve the last twenty or thirty pages for the record-

[1] Professor of Accountancy, University of Illinois, Urbana, Illinois.
[2] Scovill's *Farm Accounting*, by D. Appleton & Co.

ing of details concerning the use of labor, the work done by horses and the consumption of feed by livestock.

Accounts should be kept with cash, real estate, equipment, each person to whom or from whom money is owing; each class of livestock, each crop raised, equipment expense, miscellaneous income, household. The titles of the accounts mentioned above should be written at the tops of the pages at reasonable intervals, allowing more pages for some accounts than others. For example, the word "cash" should be written at the top of the first page, leaving about twenty pages to be used for cash entries later when pages 1, 2, 3, etc., become filled with such items. Then at the top of page 21 might be written the words "Real Estate." Only one page need be reserved for this.

Procedure.— When starting to keep accounts, the first step is the taking of a physical inventory or preparation of a list of assets and liabilities. This consists in listing the quantities and value of all assets and liabilities of the farmer. (An asset is property controlled or owned by the farmer and amounts collectible by him from others. A liability is an amount owing by the farmer to some one else.) The difference between the total assets and total liabilities is known as the net worth of the individual or business.

Assets are listed by groups as cash, real estate, equipment, livestock, etc. Details are shown under each group. For example, under "equipment" are listed wagons, plows, cultivators, and other units of machinery and tools.

With the inventory completed and the net worth calculated therefrom, one is ready to make the opening entries in the accounts. The amount of each asset, as cash, real estate, equipment, cattle, horses, corn, hay, etc., is recorded on the left side of the account bearing these respective titles. Any liabilities are recorded on the right side of the properly named liability account, as mortgage payable, White Implement Co., etc. The net worth is recorded on the right side of an account with the farmer, commonly known as proprietorship or capital account. Thus, the sum of all items on the left side of the ledger accounts is equal to the sum of all items on the right side. This equality is maintained at all times by recording for every transaction equal amounts on the left and right side of the ledger. Every transaction permits of the recording of an amount in two accounts and also requires such two-fold effect to be shown in order to present the results in the best manner.

Construction of accounts.— Presuming that all assets and lia-

bilities have been entered in the accounts, if $400 is paid out for a tractor, entries are made in the Cash and Equipment accounts as follows:

CASH

	19___ Feb. 16. F. Lynn, 1 tractor.. $400.00

EQUIPMENT

19___ Feb. 16. Cash—tractor $400.00	

When forty dollars is paid for labor, the cash is again reduced and the cost of labor is increased; hence forty dollars is placed on the right side of cash and left side of an account called labor.

It may be stated as a general rule that when any property is parted with, its value is recorded on the right side of the account bearing a title to indicate the property so parted with. At the same time, the same amount is recorded on the left side of the account that shows the reason for parting with the property. Thus, if one pays fifty dollars for household furniture, for groceries or for Christmas presents, an entry for fifty dollars is made on the right side of cash and the left side of Household account. These show respectively the property parted with and the reason therefor.

Again, if one pays five hundred dollars in reduction of a mortgage, the amount is shown on the right side of cash and left side of mortgage payable accounts.

A second general rule to follow in recording one's transactions is that when any property is received its value is recorded on the left side of the account bearing a title to indicate the property received. At the same time, the same amount is recorded on the right side of an account that shows the reason for receiving the property. For example, if one receives three hundred dollars cash from the sale of hogs, the entry is:

CASH

19___ Mar. 16. W. Wild, hogs...... $300.00	

HOGS

	19___ Mar. 16. Cash, hogs $300.00

If one borrows one thousand dollars cash on a note, the amount is recorded on the left side of cash account (the property received) and on the right side of notes payable account (the reason for receiving the cash). Cash received from the sale of milk requires an entry on the left side of cash and the right side of cattle account.

In keeping cost records of a simple type, one records all cash transactions from day to day as presented above. In addition he keeps a more or less detailed record of the quantity of crops consumed by live stock, the relative amount of labor, and horse labor performed for each farm element and the quantity of various farm products consumed by the household. Such items can be estimated daily, weekly, or monthly, or a detailed accurate record can be kept. By whatever method obtained, the quantities and hours are valued and used as a basis for making entries at the close of the year.

Entries for crops consumed by livestock are made on the right side of the accounts of each of the several crops consumed and on the left side of each of the several classes of live stock. (This complies with the general principle, because, e. g., there is less corn and more hog.) Labor account receives an entry on its right side for all labor performed (hours, time rate per hour, commonly thirty cents), the same amount being split up into several items and recorded on the left side of the various crop, livestock, household or other accounts, in the interest of which the labor was used. Similarly, the horse labor (hours, time rate per hour, commonly fifteen cents) is entered on the right side of horse account and left side of the accounts affected by the use of horses.

Depreciation on buildings and equipment, calculated at three per cent of the former and ten per cent of the latter, is recorded by showing the amounts on the right side of real estate and left side of building expense accounts in the one case, and on the right side of equipment and left side of equipment expense accounts in the other case.

Finding the profit or loss.— The profit or loss for the year is obtained after taking another inventory at the close of the year, in accordance with the following plan:

Make two columns side by side headed respectively "losses" and "gains." In the "losses" column record the amount of any balances of equipment expense, building expense, labor, general farm expense, or any other specific expense or repair account. In the "gains" column record the amount of any balances of miscellaneous income or other specific income account. Then proceed to enter all inventories of livestock, crops and household furnishings as of the close of the year on the right side of the proper accounts, as cattle inventory on right side of cattle account, corn inventory on the right side of corn account, and so on. After recording such inventories in the accounts with livestock, crops and household, the difference between the right and left side of each is listed under "losses" or "gains" in accordance with the following principle:

If the left side of any crop or livestock or household account is greater than the right, after including the inventory at the close of the year, place the difference between the two sides of the account in the column headed "losses." If the right side is greater, place the difference in the "gains column," writing the proper title (cattle, corn, etc.) to the left of each amount.

After listing all losses and gains as described above, the difference between the loss and gain columns is calculated. This represents the net gain or loss of the individual for the year. If the gains are greater, add the amount of the net gain to the proprietor's capital as shown in the proprietorship or capital or net worth account. If the losses are greater, subtract the net amount of the loss from the proprietor's capital. Such addition of net gain to or subtraction of net loss from the net worth shows the capital, proprietorship or net worth at the close of the year.

Proof of the profits.— That the profit or loss calculated is correct may be proved by making a list of assets and liabilities as they appear in the ledger, including inventories recorded for livestock and crops. Thus, the difference between the two sides each of cash, real estate, equipment and other accounts showing assets, added to the several inventories of live stock, and crops

at the close of the year is the total assets at the close of the year. Subtracting from this amount any liabilities shown by the ledger accounts gives the net worth at the close of the year. This net worth or proprietorship should be the same as that obtained by adding the gain of the year to the proprietor's account balance as described above.

Profit as a farmer.— The net gain for the year plus a "loss" on Household or minus a "gain" on Household equals the profit from farming operations.

Continuing the accounts.— The profits having been determined and proved, the accounts for the next year are started in the same way as for the beginning of the first year. Care should be exercised in ruling off or otherwise separating the accounts of two successive years.

CHAPTER XXXV

PESTS ON THE FARM AND THEIR CONTROL[1]

Meadow and pine mice and common rats.—

Damage done.— Injures farm crops, meadow and pasture grass. Eats seeds, bulbs and vegetables. Girdles fruit trees. In fact, when driven by hunger, both the Pine and Meadow mice will destroy shrubs, berry bushes, vines and many species of forest trees.

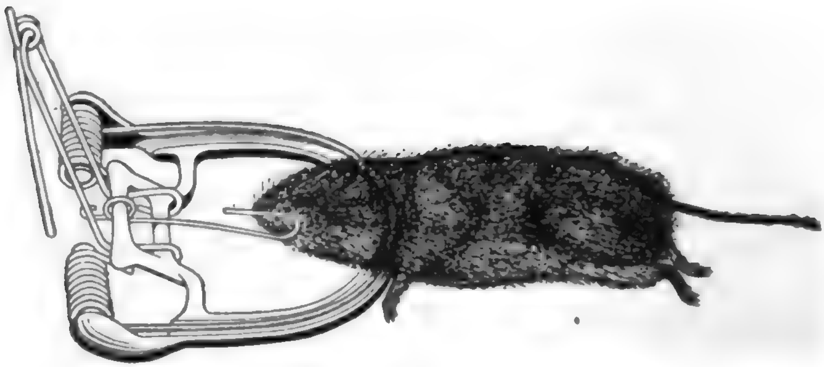

FIG. 228.—Field mouse caught in baited guillotine trap.—*U. S. Dept. of Agriculture.*

Control.— Bait guillotine traps with grain, cheese or meat and set in mouse runs. There are a number of types of rat traps on the market that are very effective.

For poisoning meadow mice on large areas the following methods are recommended:

Dry-grain formula.— Mix thoroughly one ounce powdered strychnine (alkaloid), one ounce powdered bicarbonate of soda, and one-eighth ounce (or less) of saccharin. Put the mixture in a tin pepperbox and sift it gradually over fifty pounds of crushed wheat, or forty pounds of crushed oats, in a metal tub, mixing the grain constantly so that the poison will be evenly distributed. Dry mixing has the advantage that the grain may be kept any length of time without fermentation. If it is desired to moisten

[1] Formulas taken from Bull. 932, U. S. Department of Agriculture.

the grain to facilitate thorough mixing, it will be well to use a thin starch paste (as described below, but without strychnine) before applying the poison. The starch soon hardens, and fermentation is not likely to follow.

Wet-grain formula.— Dissolve one ounce of strychnine (sulphate) in two quarts of boiling water. Dissolve two tablespoonfuls of laundry starch in one-half pint of cold water. Add the starch to the strychnine solution and boil for a few minutes until the starch is clear. Pour the hot starch over one bushel of

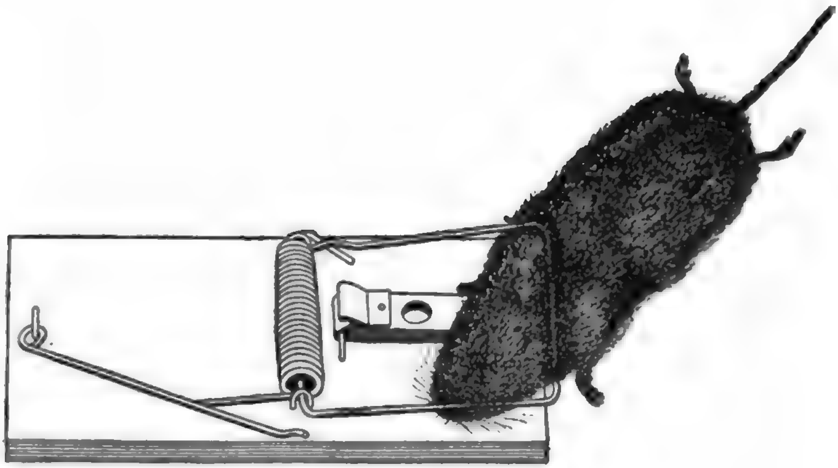

FIG. 229.—Field mouse caught in unbaited guillotine trap.—*U. S. Dept. of Agriculture.*

oats in a metal tub and stir thoroughly. Let the grain stand over night to absorb the poison.

Alfalfa formula.— One ounce of strychnine (sulphate) dissolved in two gallons of hot water was found sufficient to poison thirty pounds of chopped alfalfa previously moistened with water.

Oatmeal formula.— Dissolve one-sixteenth ounce of strychnine in one pint of boiling water and pour it over as much oatmeal (about two pounds) as it will wet. Mix until all the grain is moistened. Put it out, a teaspoonful at a place, under shelter of weed and brush piles or wide boards.

Especially recommended in destroying pine mice.

Potato formula.— Cut sweet potatoes into pieces about the size of grapes. Place three quarts of these cut baits in a pan or bucket, and from a tin pepperbox slowly sift over them one-eighth ounce of powdered strychnine mixed with an equal quantity of baking soda, stirring constantly so that the poison is

evenly distributed. Poison should be applied as soon as potatoes are cut and bait should be put out while fresh.

The poisoned bait is to be distributed over the infested area, not more than a teaspoonful at a place, care being taken to put it in mouse runs and at the entrances to burrows. To avoid destroying birds it should, whenever possible, be placed under such shelters as piles of weeds, straw, brush, or other litter, or under boards. Small drain tiles one and one-half inch in diameter have sometimes been used to advantage to hold poisoned grain, and old tin cans with the edges bent nearly together will serve the same purpose.

Young fruit trees may be protected from mice and rabbits by keeping down the weeds, protecting the bark with a fine mesh wire, one thickness placed about the trunk and by packing the light snow tightly about the trees during early winter and late spring.

Cotton rat.— *Damage done.*— Destroys growing crops and grain in shocks.

Control.— The same poisoned bait used for field mice will destroy the cotton rat.

Common rats.— The common rat may be baited with the same poisons as recommended for meadow mice. Steel traps are also effective.

Pocket gophers.— *Damage done.*— Throw up mounds, burrow in the fields, eat growing grain and vegetables. Destroy trees by gnawing the roots.

Control.— Trapping is an effective method of keeping the gophers in check.

In irrigated districts, where water is available, flooding the land will drive out the animals, and they may be killed by men and dogs. Fumigation of the burrows with carbon bisulphid or with sulphur smoke, while often recommended as a means of destroying pocket gophers, has been found extremely uncertain and costly.

Poison for pocket gophers.— Cut sweet potatoes or parsnips into pieces with the largest diameter less than an inch. Wash and drain four quarts of the cut baits. Place in a metal pan, and from a pepperbox slowly sift over the dampened baits one-eighth ounce of powdered strychnine (alkaloid) and one-tenth as much saccharin (well shaken together or ground together in a mortar), stirring to distribute the poison evenly.

Ground squirrels.— *Damage done.*— Destroy fields by burrowing through irrigation ditches and also by eating growing crops.

The Beeckey ground squirrel is known to be a carrier of bubonic plague.

Control.— Poison for Columbia ground squirrels.— Mix one ounce of powdered strychnine (alkaloid), one ounce of powdered bicarbonate of soda, one teaspoonful of saccharin, and one-half pound of dry powdered laundry starch, and stir enough cold water to make a smooth, creamy paste. Apply to twelve quarts of good, clean oats in a metal tub or other vessel, and stir thoroughly to distribute the poison evenly. When the poisoned grain

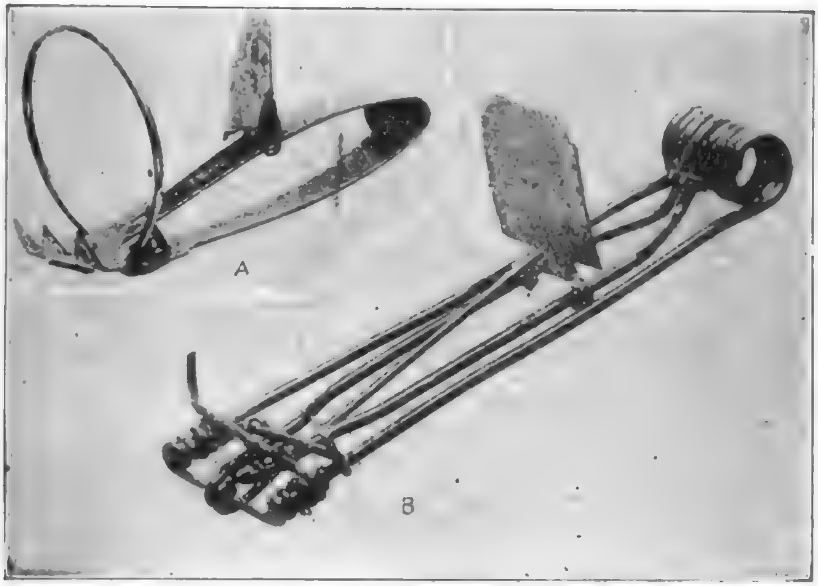

Fig. 230.—Types of special pocket-gopher traps.—*U. S. Dept. of Agriculture.*

is dry, scatter it, along squirrel trails or on hard soil on the surface near the squirrel burrows. A quart of the grain should make forty or fifty baits, and if properly distributed stock will not be endangered by this quantity.

Poison for Richardson ground squirrels.— Mix one tablespoonful of laundry starch in one-half teacup of cold water, and stir it into one-half pint of boiling water to make it a thin, clear mucilage. Mix one ounce of powdered strychnine with one ounce of powdered bicarbonate of soda, and stir the mixture into the hot starch, making a smooth, creamy paste free from lumps. Stir in one-quarter pint of heavy corn syrup and one tablespoonful of glycerin, and, finally, one scant teaspoonful of saccharin. Apply to twenty quarts of oats, and mix thoroughly to coat every kernel. Each quart of the poisoned grain should make forty to

sixty baits. Distribute in same manner as stated for poisoning Columbia ground squirrels.

Poison for California, or "digger," ground squirrels.— Prepare by same formula as for Richardson ground squirrels, but use sixteen quarts of clean barley instead of oats. Distribute as for poisoning Columbia ground squirrels.

Prairie-dogs.— *Damage done.*— Eats vegetation. Destructive to pastures.

Control.— Poison for prairie-dogs.— Mix thoroughly one ounce of powdered strychnine (alkaloid) and one ounce of common baking soda (bicarbonate). Dissolve one heaping tablespoonful of dry laundry starch in a little cold water and add it to three-quarters pint of boiling water. Boil and stir until a thin, clear paste is formed. Slowly sift the mixture of strychnine and soda into the starch paste, stirring constantly to form a smooth, creamy mass. Add one-quarter pint of heavy corn syrup and one tablespoonful of glycerin, and stir. Add one-tenth ounce of saccharin, and again stir thoroughly. Pour this mixture while still hot over thirteen quarts of clean oats and mix until all the grain is coated.

If alkaloid strychnine is not available, the sulphate may be used, either powdered or in crystals, but it is necessary to vary the formula. Dissolve the strychnine in the boiling water before adding the cold starch. After the poisoned starch paste is clear, stir in the soda very slowly. Then add the syrup, glycerin, and saccharin as in the above directions and mix with the grain.

For mixing small quantities an ordinary metal washtub is convenient. For large quantities a tight, smooth box may be used, and the mixing done with a hoe or spade.

Wheat is well adapted for winter poisoning, and in the South, where heavy oats are rarely obtainable, milo or feterita is an excellent substitute.

Woodchucks.— *Damage done.*— Burrows and mounds which interfere with farm operations. Eats vegetables, clover and other crops. Where there are but few woodchucks on the farm, shooting and trapping is advised.

Control.— They may be poisoned by strychnine inserted in pieces of sweet apple, carrot, or sweet potato. The animals are often destroyed in their burrows by fumigation with carbon bisulphid or by the discharge of blasting powder.

To destroy woodchucks with carbon bisulphid, saturate a wad of cotton or waste with about one and one-half ounce of the liquid. Place the cotton well inside the woodchuck burrow and

close the opening with a piece of sod, well stamped down. If there are two or more entrances to a burrow, all but the one in which the cotton is to be placed should be tightly closed before fumigation.

Rabbits.— *Damage done.*— Girdle young fruit trees and after deep snows often eat the buds and twigs. Eats growing crops, especially garden vegetables such as cabbage.

Control.— Poison wash.— Dissolve one ounce of strychnine (sulphate) in three quarts of boiling water. Dissolve one-half pound of laundry starch in one pint of cold water, stirring thoroughly. Pour the starch into the vessel containing the strychnine and boil the mixture a short time until the starch is clear. Add six ounces of glycerin and stir. When the paste is cool enough apply to tree trunks with a paint brush.

For poisoning jack rabbits in winter the following formula is recommended:

Poison baits.— Good oats, twelve quarts; powdered strychnine, one ounce; laundry starch, one tablespoonful; soda (bicarbonate), one ounce; saccharin, one-eighth ounce; water, one quart. Prepare as directed for mixing prairie-dog poison. Not over a tablespoonful of the poisoned grain should be used in a single bait, and this should be scattered considerably. A little alfalfa hay may be used to attract rabbits to the grain. The poison is especially effective when snow covers the ground.

Partly ripened or ripe heads of barley or wheat soaked in a sweetened solution of strychnine or coated with the starch-strychnine paste just described have also proved effective bait for rabbits, but care must be exercised in using them, as they are likely to be eaten by live stock.

Moles.— *Damage done.*— Eats the roots of crops. Especially bad on lawns, burrowing close to the surface.

Control.— Special mole traps on traveled burrows. Fresh corn treated with strychnine placed in the burrows is effective.

Mosquitoes.— *Control.*— Cover rain barrels, drain off standing water or fill in the hollows. Eliminate all breeding places by disposing of the water or covering the container. One ounce of kerosene to fifteen square feet of water will destroy the larvæ as they come to the surface to breathe. Top minnows, sunfish, sticklebacks and goldfish will destroy the larvæ.

House ants.*— *Control.*— The distinctively house-inhabiting ants, such as the little red or Pharaoh's ant, and other imported

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* F. B. 740, U. S. Department of Agriculture.

species nesting in the woodwork, masonry, or articles of furniture, etc., are often very difficult to eradicate because of their inaccessibility. If the nest can be located by following the workers back to their point of disappearance, the inmates of the nest, if near by, may sometimes be reached by injecting a little disulphid of carbon, kerosene, or gasoline into the opening by means of an oil can or small syringe. In the use of these substances, naturally, precautions should be taken to see that no fire is present, as all of them are inflammable. If the nest is under flooring it may sometimes be gotten at by removing a section; but, as a rule, unless the colony can thus be reached and destroyed, other measures are of only temporary avail if food or other conditions continue to attract the ants and facilitate their continued breeding in the houses.

The removal, therefore, of the attracting substances in houses, wherever practical, should be the first step. Ants are attracted by food material, especially cake, bread, sugar, meat, and like substances, in pantries and elsewhere, and the nuisance of their presence can be largely limited by promptly cleaning up all food scattered by children and by keeping in the pantry or storeroom all food supplies which may attract ants, in ant-proof metal containers or in ice boxes, and limiting the amount of such articles as far as possible to daily needs.

It has been asserted that it is possible to drive ants away from household supplies by the use of repellants, particularly camphor and napththalene flakes or powdered moth balls. The use of most of such repellant substances, however, in connection with food supplies, is impractical, and careful tests have indicated that such substances have only slightly repellant properties and bring comparatively little benefit.

The collection of ants by the use of attractive baits is frequently recommended. Perhaps as convenient a bait as any consists of small sponges moistened with sweetened water and placed in situations where they can be easily reached by the ants. These sponges may be collected several times daily and the ants swarming on them destroyed by immersion in hot water. It is reported also that a syrup made by dissolving borax and sugar in boiling water and distributed on sponges will effect the destruction of the ants in numbers. Remedies of this kind, however, are of doubtful value. They may be useful at the outset when the colonies are few and small and when most of the individuals may, by these means, be secured and destroyed. Very frequently, however, the distribution of such baits will simply

result in a more wide exploitation of a good forage ground and an actual increase of the ant nuisance.

A more efficient remedy, where it can be safely used, is a syrup poisoned with arsenate of soda, the idea being that the ants will collect this poison syrup and convey it to their nests, so that not only the ants which collect the syrup are ultimately killed, but the inmates of nests feeding on it also succumb. The formula

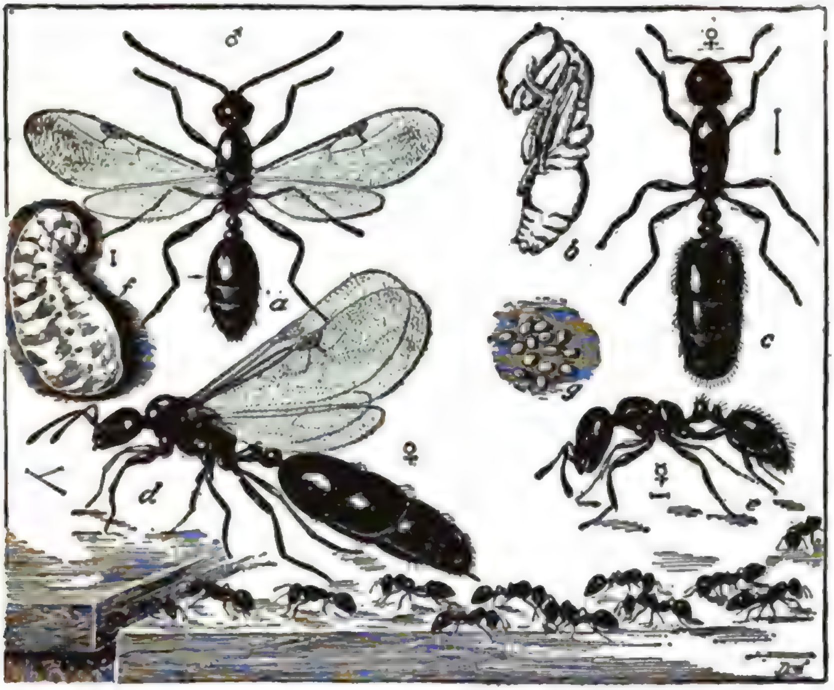

FIG. 231.—The little black ant (*Monomorium minimum*). *a*, Male; *b*, pupa; *c*, female; *d*, same with wings; *e*, worker; *f*, larva; *g*, eggs; group of workers in line of march below. All enlarged, the lettered illustrations all drawn to the same scale.—*U. S. Dept. of Agriculture.*

for the preparation of this syrup is as follows: One pound of sugar dissolved in a quart of water, to which should be added 125 grains of arsenate of soda. The mixture should be boiled and strained, and on cooling used with sponges, as already described. The addition of a small amount of honey is said to add to the attractiveness to ants of this mixture. Naturally the greatest precautions should be taken in preparing this syrup and in safeguarding it afterwards to prevent its being the cause of poisoning to human beings or domestic animals. This method

of control has been tested for three years by an expert[1] of the Bureau of Entomology of this department and has given very satisfactory results. Similar success with it has been reported by others, including persons engaged professionally in insect extermination. A related formula experimentally worked out for the Argentine ant is given in a special bulletin on this insect.[2] This formula is as follows:

Granulated sugar	15	pounds
Water	7½	pints
Tartaric acid (crystallized)	¼	ounce

Boil these ingredients together slowly for thirty minutes and allow to cool. Then slowly dissolve three-fourths ounce sodium arsenite ($NaAsO_2$) in one-half pint of hot water. Allow this to cool, then add it to the syrup, stirring thoroughly. Add one and one-half pounds of pure honey to the syrup and the mixture is ready for use.

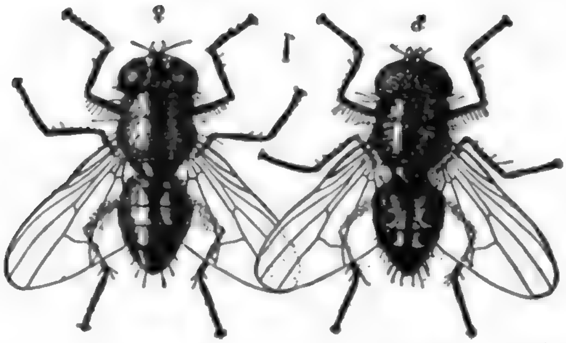

FIG. 232.—A "little house fly" (*Fannia brevis*). Female at left, male at right. Much enlarged.

House fly (*a disease carrier*).—

Control.—The fly breeds in manure (horse), garbage and filth. Erect fly-proof manure pits or scatter manure on the soil once each week. All garbage cans should be covered with a tight-fitting lid. Clean up all filth in which flies might breed.

Stable fly.—Attacks warm-blooded animale, disturbing and irritating them. Certain diseases are transmitted by these flies.

FIG. 233.—The true house fly (*Musca domestica*). Enlarged.—*U. S. Dept. of Agriculture.*

Control.—In Farmers' Bulletin 540, U. S. Department of Agriculture, the following repellant is recommended: "A mixture of fish oil (one gallon), oil of pine tar (two ounces), oil of pennyroyal (two ounces), and kerosene (one-half pint) was

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1 C. H. Poponoe

2 Barber, E. R. *The Argentine Ant: Distribution and Control in the United States,* U. S. Dept. Agri. Bul. 377.

found to be very effective in keeping the flies off live stock when applied lightly but thoroughly to the portions of animals not covered with blankets or nets."

According to F. C. Bishop of the Department of Agriculture, the fly breeds in straw stacks throughout the grain belt. He recommends that the stack should be built so that the sides are nearly vertical and rounding it up well on top, in order to better shed the rain.

Destroy old stacks. Manure pits or cellars should be made fly-proof.

Grasshopper.— Feeds on growing plants, usually grass and weeds.

Control.— Fall plowing six to ten inches in depth is highly recommended.

The poison baits and spray mixture are suggested in Extension Bulletin 4, New York State College of Agriculture.

"Kansas Bait."—

Bran	20	pounds, mix dry
Paris green	1	pound, mix dry
Oranges (or lemons)	3,	chop fine
Molasses	2	quarts
Water	3½	gallons

Mix so as to form a mash not too moist, scatter over infected field, either early in the morning or late in the afternoon. The insects will not eat this mixture if dry.

"Criddle mixture."—

Paris green	1 pound
Salt	2 pounds
Horse manure (preferably fresh)	50 pounds

Add enough water to make the mixture moist and scatter it over the infested area.

Sprays.— Apply early in the season.

Arsenate of lead	5 pounds
Water	50 gallons

Another effective solution.—

Paris green	1½	pounds
Water	50	gallons
Fresh lime	1	pound

If the sodium arsenate is used it should be applied at the rate of one pound of the commercial preparation to sixty gallons of water, with two quarts of molasses.

CHAPTER XXXVI

WEEDS AND THEIR CONTROL

Introduction.— Every progressive farmer is to-day fighting the serious and persistent menace, weeds. The United States government realizing the importance of the control or eradication has passed laws relating to certain practices which the

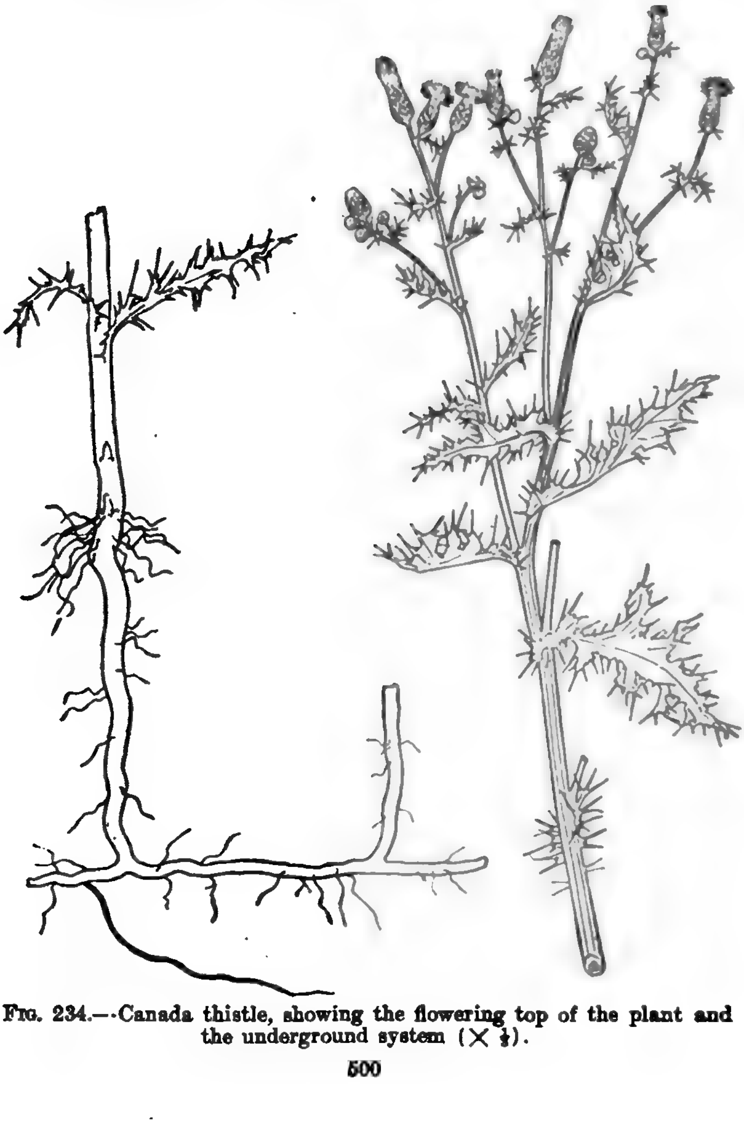

FIG. 234.—Canada thistle, showing the flowering top of the plant and the underground system (× ½).

FIG. 235.—Wild Buckwheat. 1, Entire plant; 2, plant winding around a stalk of timothy; 3, root system; 4. seedling; 5, seedling somewhat older; 6, seed natural size and enlarged.

farmers should follow in destroying weeds, but these laws have been very ineffective. If the farmers would coöperate in the control of such weeds as the Canadian thistle, milkweed, and others, they might in a short time free the community of them. The man who has a weedy farm not only loses a large per cent of his own crops because of the loss of moisture, plant food, crowding, shading, etc., but he allows the seed to ripen and thus the adjacent fields of his neighbors become infested and so this menace spreads.

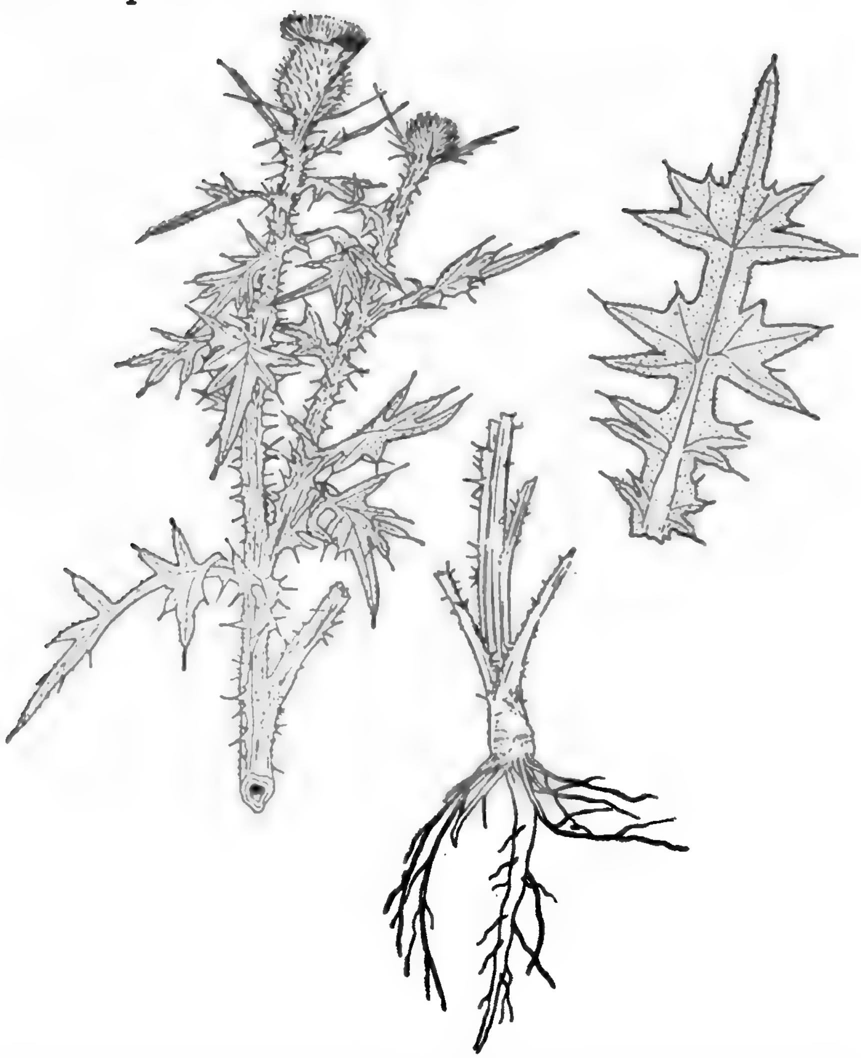

FIG. 236.—Bull thistle, showing flowering top of plant, separate leaf and roots (× ½).

The farmer should be able to answer the following questions before effective work can be done in the control and eradication of weeds:

1. Is the plant an annual? This type of plant comes from seed in the spring, grows, bears flower and seed, and dies in one year. One of the most effective methods of control is to destroy the plant before the seed ripens.

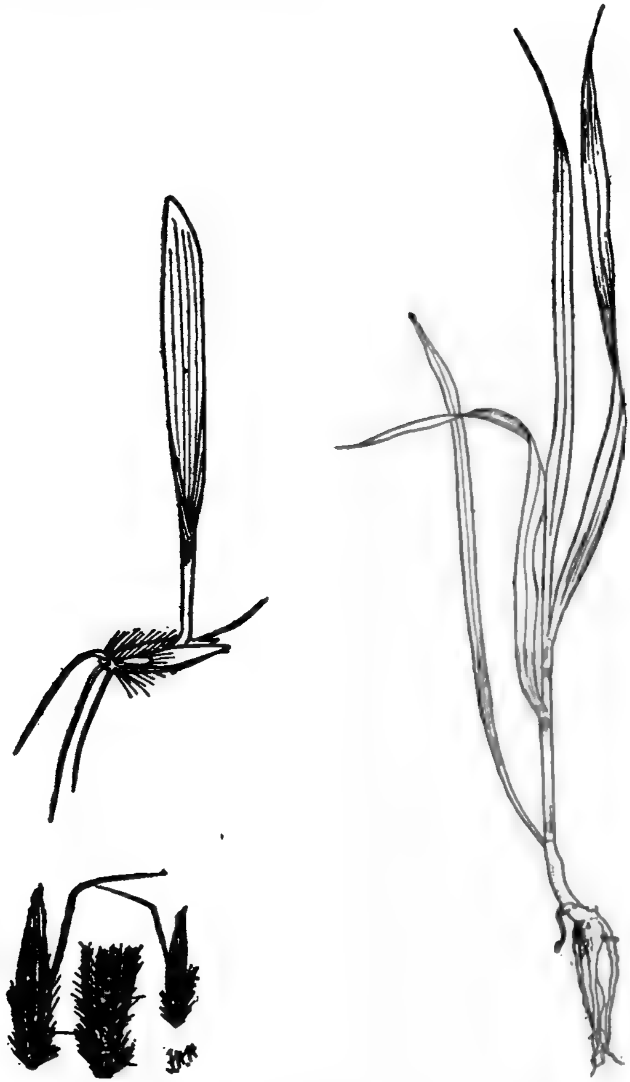

FIG. 237.—Two stages of growth of the wild oats seedling (natural size); also enlarged and natural sized drawings of the seed.

2. Is the plant a biennial? The seed produces the plant but no flower the first year. The roots withstand the winter and produces the flower and seed the second year, after which the plant dies. Fall plowing or cutting the plant off below the crown is effective.

3. Is the plant a perennial? This type of plant blooms and

FIG. 238.—Wild oats, showing the fruiting panicle and the root system (× ½).

produces seed year after year. The seed production may be controlled by mowing. The roots, bulbs and underground stems may be destroyed by fall plowing and continual cultivation.

4. How does the weed spread? Are the seeds carried by the wind, birds, animals, man, insects or water? Does the plant spread by roots, runners, suckers, or underground stems or in other ways?

5. When does the flower appear? This point is important because if the flower is discovered before the seeds are formed the plant may be eradicated by spraying, mowing or cultivation.

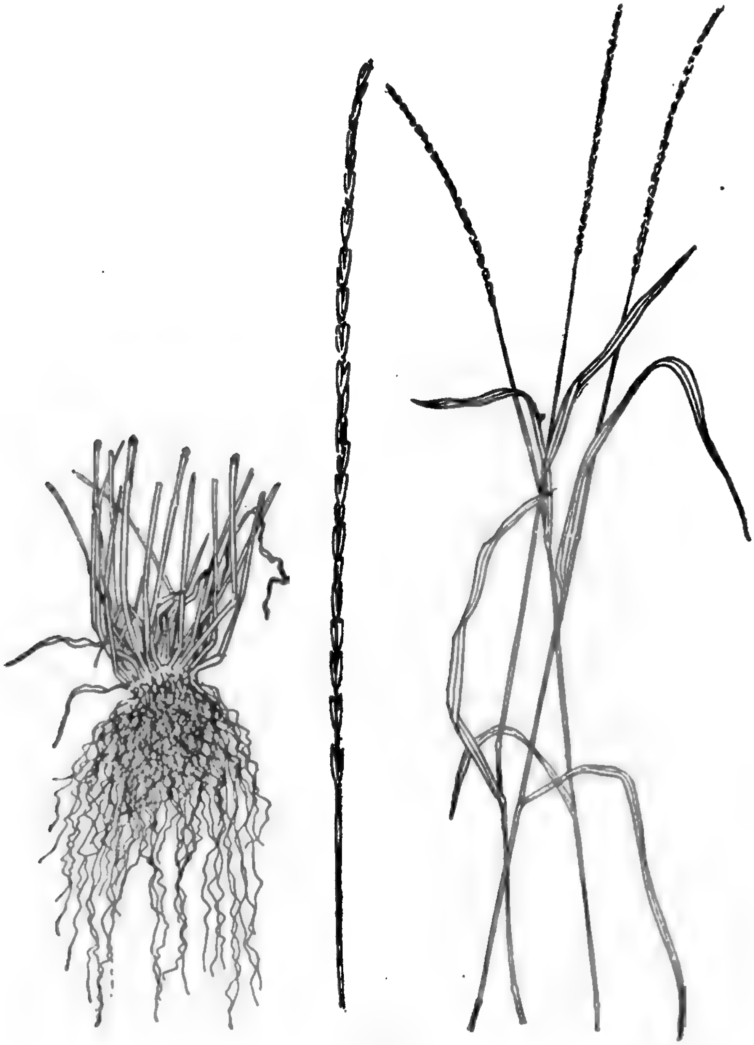

FIG. 239.—Slender wheat grass, showing root system and single spike ($\times \frac{1}{3}$); plant ($\times \frac{1}{8}$).

6. When does the seed ripen? If the seed ripens and falls there is little chance of destroying the weed unless it is plowed under, eight to ten inches, in the fall. This method of control is not always satisfactory. It is advisable to burn the plant and seeds.

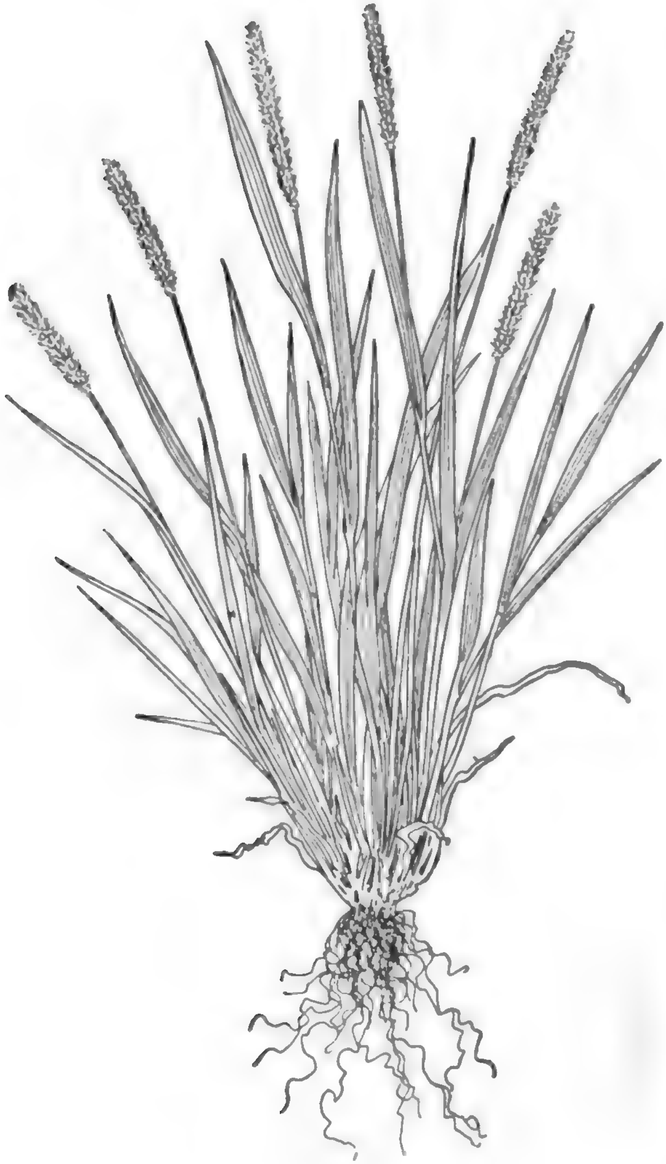

FIG. 240.—Yellow foxtail, entire plant (× ⅓).

7. Last and most important of all the farmer wants to know the best method of control.

The following methods are effective:

1. Mow down the weeds before the seed is ripened.
2. Burn weeds which have matured their seed.

FIG. 241.—Three stages of growth of the quack grass seedling (natural size); also enlarged drawing of the seed and spikelet.

3. Plow in the fall and expose the root, bulbs or underground stem, or seed to the elements.
4. Practice crop rotations.
5. Sow clean seed and persistently cultivate.

6. Get acquainted with the common weeds and be alert for new species. Report the weeds you are not familiar with to your experiment station or the United States Department of Agriculture.

Fig. 242.—Quack grass, showing the entire plant system both above and below the ground (× ⅓).

7. Pasture sheep in weedy fields.
8. Spray with copper sulphate, iron sulphate or common salt in solution (see methods of control).
9. Coöperate in the control of weeds and see that you follow the laws of the State and help your neighbor to do the same. Keep the roadsides cut close.

FIG. 243.—Witch grass. 1, Entire plant; 2, seedling; 3, seed natural size and enlarged.

FIG. 244.—Crab grass. 1, Entire plant; 2, enlarged flower spike; 3, seedling; 4, seedling somewhat older; 5, seed natural size and enlarged.

LOSSES CAUSED BY WEEDS

1. Weeds rob the plants of nutriment.
2. Weeds rob the plants of water.

WATER REQUIREMENT (U. S. Dept. Agri.) PLANT	NUMBER OF POUNDS OF WATER THAT MUST PASS THROUGH A PLANT TO PRODUCE ONE POUND OF DRY MATTER
Proso millet	293
Kurak millet	261
Ferterita	323
Corn	368
Wheat	513
Barley	534
Oats	597
Sweet clover	770
Alfalfa	831
Pigweed	287
Russian thistle	336
Gumweed	608
Sunflower	683
Lamb's quarters	801
Ragweed	948

3. Weeds, shade, crowd and weaken cultivated plants.
4. Weeds harbor pests such as insects, disease, rabbits, mice, etc.
5. Weeds injure and often kill stock.
6. Weeds increase labor, make harvesting difficult and detract from the appearance of the farm.
7. Weed seeds mixed with grain or other seed always lowers the price.
8. Weeds stop up drainage and often cause great loss.

FIFTY WORST WEEDS*

Table I gives an alphabetical list of the fifty worst weeds of the United States, with such information as will enable the reader: (1) To identify them, (2) to determine the nature and place of their greatest injuriousness, (3) to determine their duration or natural length of life; that is, whether annual, biennial, or perennial. With this knowledge one will be able to attack much more intelligently any troublesome weed.

* United States Department of Agriculture.

FIG. 245.—Wild mustard, showing top of plant (× ½), and slightly enlarged pod and flower.

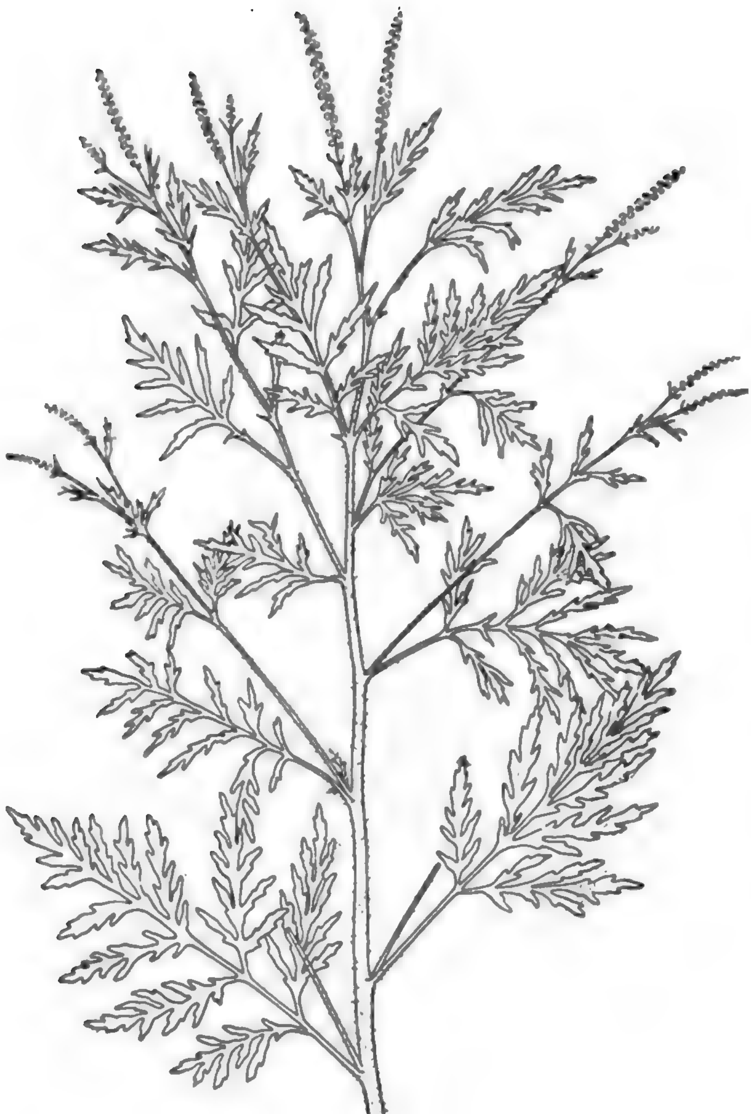

FIG. 246.—Ragweed, showing top of plant (× ½).

FIG. 247.—Buckhorn plantain. 1, Entire plant; 2, seedling; 3, seedling somewhat older; 4, seed natural size and enlarged.

FIG. 248.—Sheep sorrel, entire plant ($\times \frac{1}{2}$).

DESCRIPTIVE LIST OF THE FIFTY WORST WEEDS OF THE UNITED STATES
[A=annual, B=biennial, P=perennial]

COMMON NAME, BOTANICAL NAME, AND DURATION OF LIFE	COLOR, SIZE, AND ARRANGEMENT OF FLOWERS	SECTIONS WHERE INJURIOUS	METHOD OF SEED DISTRIBUTION; VEGETATIVE PROPAGATION OF THE PERENNIALS	PLACE OF GROWTH AND PRODUCTS INJURED
Bermuda[1] grass, wire-grass (*Capriola dactylon*), P.	Purple; 1/12 inch; spikes.	Maryland to Missouri and southward.	Seeds sparingly; rootstocks.	Fields and lawns; hoed crops.
Bindweed, field bind- (*Chrysanthemum leucanthemum*), P.	White or pink; 1 inch; solitary.	Entire United States, especially California.	Grain and flax seeds; creeping roots.	Rich moist soils; grain and hoed crops.
Bindweed, wild morning glory (*Convolvulus sepium*), P.	White or rose; 2 inches; solitary.	Mississippi Valley region.	Grain and flax seeds; rootstocks.	Rich prairie and river bottoms; corn and small grain.
Bitterweed, fennel, yellow dog fennel (*Helenium tenuifolium*), A.	Yellow; ¾ inch; head.	Virginia to Kansas and southward.	Wind, hay, animals.	Meadows and pastures; injures live stock and taints milk.
Broom sedge (*Andropogon virginicus*), P.	Green; ½ inch; racemes.	Massachusetts to Michigan, Florida, and Texas.	Wind; short rootstocks, plants in tufts.	Fields and waste lands; pastures and meadows.
Buffalo bur, sand bur (*Solanum rostratum*), A.	Yellow; ½ inch; solitary.	Illinois and Colorado to Texas.	Plants rolled by wind; seeds in hay and by animals.	Fields; grain and hoed crops, wool.
Bull nettle, horse nettle (*Solanum carolinense*), P.	Purple; 1 inch; solitary.	Entire United States.	Plants rolled by wind; running roots.	Everywhere; grain and hoed crops, pastures.
Bur-grass, sand bur (*Cenchrus carolinianus*), A.	Green; ½ inch; bur.	Maine to Florida and westward to Colorado.	Animals, especially sheep.	Sandy land pastures and waste places; pastures and wool.
Chess, cheat (*Bromus secalinus*), A.	Green; spikelets in panicles.	All grain sections.	Grain seed; especially wheat.	Everywhere; grain fields.
Chickweed, common chickweed (*Alsine media*), A.	White; ½ inch; cymes.	Entire United States.	Grass and clover seed, animals; has a long seeding period.	Meadows, lawns; winter crops.
Cocklebur, clotbur (*Xanthium americanum*), A.	Green; ¾ inch; head.	Entire United States.	Carried by animals.	Cultivated fields and waste places; hoed crops and wool.
Crab-grass (*Syntherisma sanguinale*), A.	Green; spikes.	Entire United States, especially the South.	Clover and grass seed, hay, animals.	Cultivated fields, gardens, lawns; hoed crops.
Daisy, oxeye daisy (*Chrysanthemum leucanthemum*), P.	White with yellow center; 1 inch; heads.	Maine to Virginia and Kentucky.	Clover seed, hay; woody, rather short rootstocks, but largely by seed.	Pastures, meadows, roadsides; hay, pasturage.
Dandelion (*Taraxacum officinale*), P.	Yellow; 1½ inch; head.	Entire United States.	Wind; taproot, which spreads but little.	Lawns, meadows, waste places; hay and lawns.
Dock, yellow dock, sour dock (*Rumex crispus*), P.	Green; ½ inch; panicle.	Entire United States.	Hay and straw, clover and grass seed; taproot, which spreads but little.	Hay, small grain and hoed crops.

[1] The fact that Bermuda grass is often troublesome as a weed in places where it is not desired is in no way contradictory to the fact that it is the most valuable pasture grass in the South. With proper rotations Bermuda grass is rarely a serious weed. Where only intertilled crops are grown, such as cotton, Bermuda grass perhaps occasions more additional cultivation than any other plant. For the valuable features of Bermuda grass consult Farmers' Bulletin 814.—C. V. PIPER.

DESCRIPTIVE LIST OF THE FIFTY WORST WEEDS OF THE UNITED STATES—*Continued*

COMMON NAME, BOTANICAL NAME, AND DURATION OF LIFE	COLOR, SIZE, AND ARRANGEMENT OF FLOWERS	SECTIONS WHERE INJURIOUS	METHOD OF SEED DISTRIBUTION; VEGETATIVE PROPAGATION OF THE PERENNIALS	PLACE OF GROWTH AND PRODUCTS INJURED
Dodder, alfalfa dodder, field dodder (*Cuscuta arvensis*), A.	Yellow; 1/8 inch; clusters.	All clover and alfalfa regions.	Hay, clover and alfalfa seed.	Clover and alfalfa fields.
Dogbane, Indian hemp (*Apocynum cannabium*), P.	Greenish white; 1/4 inch; terminal clusters.	Upper Mississippi Valley.	Wind; creeping root.	Fields with sandy soil; pasture, grain and hoed crops.
Fern, brake (*Pteridium aquilinum*), P.	No flowers.	Northwestern States and the Pacific coast.	Spores scattered by wind; running roots.	Logged-off land, meadows, and pastures.
Fleabane, horseweed (*Erigeron canadensis*), A.	White; 1/8 inch; heads in cymes.	Entire United States.	Hay, grass, and clover seeds.	Meadows, pastures, and grain fields.
Foxtail, yellow foxtail, pigeon grass (*Chaetochloa glauca*), A.	Green; spikes.	Entire United States.	Animals, hay, grain, and grass seeds.	Land cultivated in early part of season; young grass and clover seedlings.
Hawkweed, orange hawkweed, devil's-paintbrush (*Hieracium aurantiacum*), P.	Orange; 1 inch; heads.	Maine to Ohio.	Wind, grass and clover seeds; runners similar to strawberry.	Untillable pastures and meadows.
Ironweed (*Vernonia noveboracensis*), P.	Purple; 1/4 inch; heads.	Maine to Maryland and Iowa to Kansas.	Wind; short thick rootstocks, making plant grow in bunches.	Pastures and meadows.
Jimson weed (*Datura stramonium*), A.	Purple; 3 inches; solitary.	Maine to Minnesota and Texas.	Pods and plants blown by wind.	Pastures, barnyards, and waste lands; seeds, flowers, and leaves poisonous.
Johnson grass (*Holcus halepensis*), P.	Green; 1/4 inch; panicle.	Virginia to Texas and California.	In hay, grain, and grass seed; running rootstocks.	All crops except hay.
Lamb's-quarters, pigweed (*Chenopodium album*), A.	Green; very small; panicle.	Entire United States.	Grain and grass seed.	Grain fields and hoed crops.
Lettuce, prickly lettuce (*Lactuca virosa*), A.	Yellow; 1/4 inch; heads in panicles.	Ohio to Iowa, Utah to California.	Wind.	Everywhere; all crops.
Milkweed, common milkweed (*Asclepias syriaca*), P.	Purple; 1/4 inch; umbels.	New York to Minnesota.	Wind; creeping roots.	All crops and in pastures.
Morning-glory (*Ipomea hederacea*), A.	White, purple, or blue; 1½ inch; solitary.	New York to Missouri.	Corn stover, straw, and wind.	Cultivated fields, especially corn, and small grain.
Mustard, wild mustard, charlock (*Brassica arvensis*), A.	Yellow; 1/2 inch; racemes.	Maine to Washington.	Grain, grass, clover, and rape seeds.	Small grain fields and meadows; grains.
Nut-grass, coco (*Cyperus rotundus*), P.	Brown; 1/16 inch; spikelets.	Maryland to Florida and Texas.	Wind, nursery stock, hay, and grass seed; tubers.	All soils; hoed crops.
Pennycress, Frenchweed (*Thlaspi arvense*), A.	White; 1/8 inch; racemes.	North Dakota and Minnesota.	Wind.	Grain fields and pastures; grain and dairy products.
Pigweed, redroot, careless weed (*Amaranthus retroflexus*), A.	Green; quite small; spikes in panicles.	Entire United States.	In grain and grass seeds; plants blown by wind.	Plowed land; hoed crops.
Plantain, buckhorn, ribgrass (*Plantago lanceolata*), P.	White; 1/16 inch; spike.	Entire United States.	Hay, clover and grass seed; spreads but slowly from a crown.	Everywhere; meadows, pastures, and lawns.

Descriptive List of the Fifty Worst Weeds of the United States—*Continued*

COMMON NAME, BOTANICAL NAME, AND DURATION OF LIFE	COLOR, SIZE, AND ARRANGEMENT OF FLOWERS	SECTIONS WHERE INJURIOUS	METHOD OF SEED DISTRIBUTION; VEGETATIVE PROPAGATION OF THE PERENNIALS	PLACE OF GROWTH AND PRODUCTS INJURED
Poison ivy, poison oak (*Rhus toxicodendron*), P.	Greenish white; ⅛ inch; panicles.	Entire United States.	Does not spread fast by seeds; running rootstocks.	Moist rich land, along fences; poisonous by contact.
Purslane, pusley (*Portulaca oleracea*), A.	Yellow; ¼ inch; solitary.	Entire United States.	Tillage implements; has a long seeding period.	Rich cultivated land, especially gardens; hoed crops.
Quack-grass, witch-grass (*Agropyron repens*), P.	Green; spike.	Maine to Pennsylvania and Minnesota.	Seeds of grain and coarse grasses; creeping rootstocks.	All crops on the better soils; hoed crops.
Ragweed, smaller ragweed (*Ambrosia elatior*), A.	Yellow; ⅛ inch; small heads on spikes.	Entire United States.	Wind carrying matured plants; in grain and red-clover seeds.	Everywhere, especially grain stubble; hoed crops and young grass seeding.
Russian thistle, tumbleweed (*Salsola pestifer*), A.	Purplish; ⅛ inch; solitary.	Minnesota to Washington and southward.	Wind rolling matured plants.	Everywhere; small grain and hoed crops.
St.-John's-wort (*Hypericum perforatum*), P.	Yellow; ¾ inch; cymes.	Maine to North Carolina and Iowa.	In hay and grass seed; rootstocks.	Meadows, pastures, and waste places.
Smartweed (*Polygonum pennsylvanicum*), A.	Light rose; 1/16 inch; racemes.	Maine to Minnesota, Florida, and Texas.	Wind carrying matured plants.	Moist rich soils; hoed crops and young grass seedings.
Smartweed, marsh smartweed, devil's-shoestring (*Polygonum muhlenbergii*), A.	Rose color; 1/16 inch; spikes.	Indiana to Iowa.	Wind and farm machinery; rootstocks.	Wet land, prairie, and muck soils; hoed crops, hay, pasture.
Sorrel, sheep sorrel, horse sorrel (*Rumex acetosella*), P.	Red; ⅛ inch; panicles.	Entire United States.	In clover seed; creeping roots.	Meadows and pastures.
Sow thistle, perennial sow thistle, field sow thistle (*Sonchus arvensis*), P.	Yellow; ¾ inch; heads.	Maine to Minnesota.	Wind; running rootstocks.	Grain fields and hoed crops.
Squirreltail grass, squirrel grass, foxtail, wild barley (*Hordeum jubatum*), A.	Green; spike with long bristly glumes.	Minnesota to Texas and California.	Hay, animals, wind.	Meadows and pastures; barbed seeds produce sores on live stock.
Thistle, Canada thistle (*Cirsium arvense*), P.	Purple, ¾ inch; heads.	Maine to Pennsylvania and Washington.	Wind, in hay and straw and in clover and grass seed; creeping roots.	All crops.
Thistle, common thistle, bull thistle (*Cirsium lanceolatum*), B.	Reddish purple; 1 inch; heads.	Maine to Virginia and Washington.	Wind, in alfalfa, clover, and grass seeds.	Pastures, meadows, and winter wheat.
Wild carrot (*Daucus carota*), B.	White; very small; umbels.	Maine and Virginia to the Mississippi.	In foreign clover and alfalfa seed; carried by animals and wind.	Meadows and pastures.
Wild oats (*Avena fatua*), A.	Green; panicles; similar to oats.	Wisconsin to Washington.	In seed oats.	Oat fields; awns injurious to stock.
Wild onion, garlic (*Allium vineale*), P.	Flowers rare; umbels with bulblets.	Rhode Island to Georgia and west to Missouri.	Seeds rare; bulblets carried in wheat; underground bulbs.	Everywhere; wheat and dairy products.
Winter cress, yellow rocket (*Barbarea vulgaris*), P.	Yellow; ¼ inch; recemes.	Maine to Virginia and westward.	In grain, clover, and grass seeds.	Grain fields, pastures, and meadows.

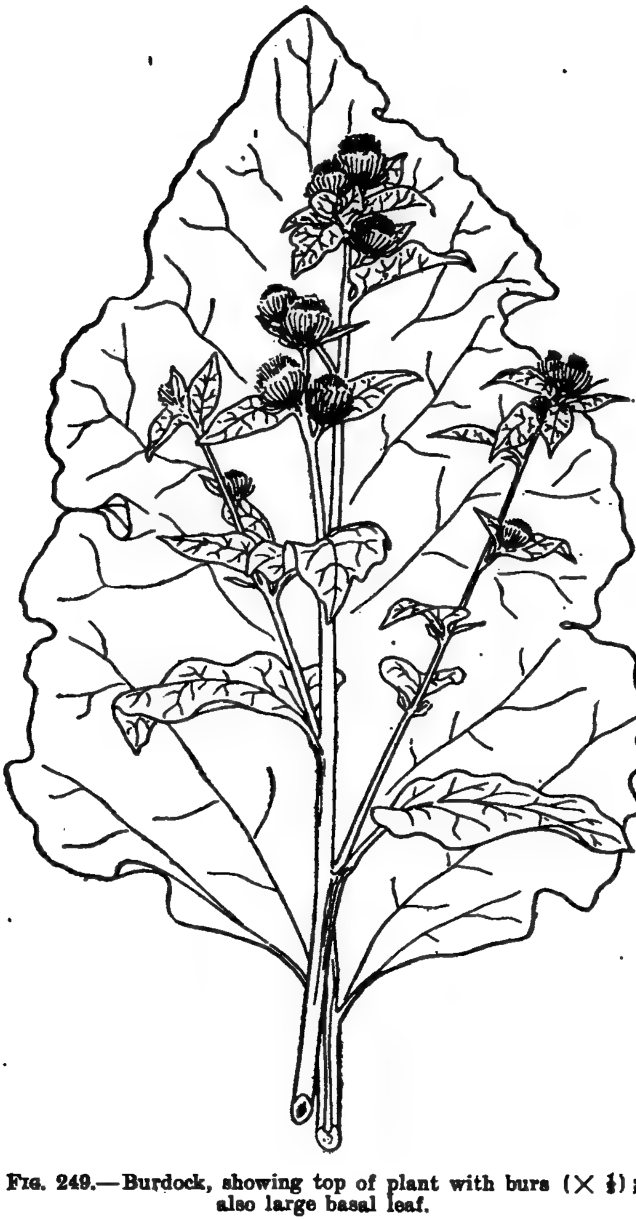

FIG. 249.—Burdock, showing top of plant with burs (× ⅛); also large basal leaf.

FIG. 250.—Blue vervain. 1, Top of plant; 2, seed natural size and enlarged.

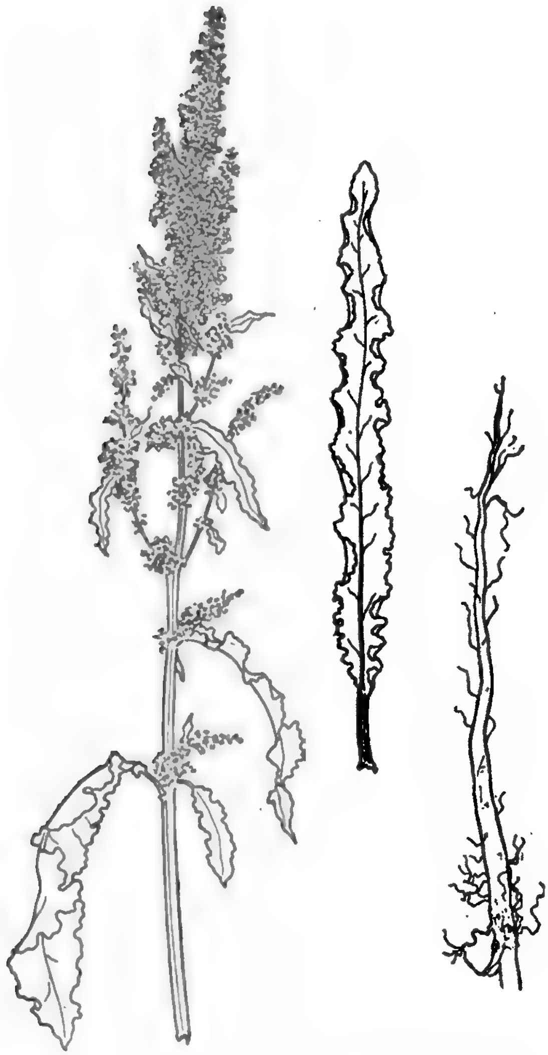

FIG. 251.— Curled dock, showing a separate leaf and root (× ⅓).

FIG. 252.—Shepherd's purse, entire plant (× ½) and an enlarged pod (× 3).

METHODS OF CONTROL

COMMON NAME	TIME OF FLOWERING	SEED TIME	CONTROL
Bermuda grass	July to August	August to September	Fall plowing (shallow), smother out by cropping land with squash, cow-peas, etc.
Bindweed (field)	June to September	August to October	Fall cultivation. Sow clean seed. Smother by cropping infected land. Pasture sheep.
Bindweed (wild morning-glory)	June to August	July to October	Keep cut back. Control same as Field Bindweed.
Bitterweed	June to August	July to September	Destroy before seed ripens.
Broom sedge	July and	September to October	Cultivate. Mow before seeding. Burn mature plants and so destroy the seeds.
Buffalo bur	May to September	July to November	Cut before seed ripens. Smother out by seeding heavily.
Bull nettle	May to September	June to November	Continual cutting. Cutting below the surface will starve the roots and prevent the development of seed.
Bur-grass	June and July	July to September	Burn mature plants. Cultivate.
Chess Cheat	June to July	July to August	Hand pulling. Cultivation in fall. Plow under. Plant clean seed.
Chickweed	Spring until frost	Throughout the year	Cultivation. Spray iron sulphate.
Cocklebur Clotbur	July to September	September to November	Pull or cut before the burs are formed. Spray, iron or copper sulphate.
Crab-grass	July to September	August to October	Cultivation. Fall plowing. Hand pulling. Prevent seeding.
Daisy	May to October	June to November	Rotation of hoe crops. Prevent seeding. Sow clean seed.
Dandelion	Spring until fall	May to November	Cut below crown. Fall plowing (shallow). Spray, copper or iron sulphate.
Yellow dock	June to September	July to October	Deep cultivation. Cut below the crown. Prevent seeding.

FIG. 253.—Lamb's quarters, showing top of plant and root system (× ⅓).

METHODS OF CONTROL—*Continued*

COMMON NAME	TIME OF FLOWERING	SEED TIME	CONTROL
Dodder	July to September	August to October	Plant clean seed. Spray, iron sulphate. Cover infected area with straw and burn.
Dogbane	June and July	August to October	Keep cut. Cultivate in summer. Strong salt brine.
Fern (brake)	....	Spores ripe in August	Cut close to ground in June. Cultivate and lime the soil.
Fleabane	June to October	August to November	Cultivate land with hoed crops. Cut close to surface. Hand pulling.
Foxtail	July and August	August and September	Fall plowing (shallow). Sow clean seed. Pasture sheep.
Hawkweed	June to September	July to October	Shallow cultivation. Fall plowing. Keep cut close to surface. Dry salt treatment.
Iron weed	July and August	September and October	Cultivate. Plant hoed crops. Keep cut back. Prevent the seed from ripening.
Jimson weed	....	....	Prevent seeding.
Johnson grass	June to July	August to September	Prevent bloom. Pasture sheep or cattle. Cultivate when possible. Fall plowing (shallow).
Lamb's quarters	June to September	August to November	Cultivate throughout the season. Hand pulling.
Lettuce	July to October	August to November	Cut off below the crown. Prevent seeding. Pasture sheep.
Milkweed	June to August	August to October	Cut before seed ripens. Smother out by cropping.
Morning-glory	May to September	July to October	Prevent seeding. Keep cut close to surface. Cultivate.
Mustard	May to September	June to October	Spray iron or copper sulphate before the grains head. Shallow cultivation. Graze sheep. Hand pulling in the garden.

FIG. 254.—Russian thistle, showing branch of young plant ($\times \frac{1}{2}$) in the center, one of a mature plant ($\times \frac{1}{3}$) at the right, and a small drawing of the entire plant ($\times$ 1-15) showing general shape at the left.

METHODS OF CONTROL—*Continued*

COMMON NAME	TIME OF FLOWERING	SEED TIME	CONTROL
Nut-grass	July to September	August to November	Sow clean seed. Prevent seed ripening. Cultivate late. Smother out by cropping.
Pennycress	June to September	June to September	Burn seeded plants. Cultivate.
Pigweed	July to September	August to November	Cut off below surface soil. Prevent seedage. Spray, copper or iron sulphate.
Plantain	April to October	May to November	Cut off below crown. Plant hoed crops. Plow in the fall.
Poison ivy	May to July	Ripe in September	Dig out as much of the roots as possible. Pour caustic soda on roots.
Purslane	June until frost	July to November	Cultivate. Prevent seedage.
Quack grass	June	July to August	Fall plowing. Pasture sheep. Prevent seeding. Deep cultivation throughout summer. Plant such crops as squash and smother out. Gather roots by hand while spading the garden.
Ragweed	July to September	August to November	Spray, iron or copper sulphate. Prevent seedage. Cultivate when plants are small.
Russian thistle	July to September	Seed ripe in October	Prevent seedage. Plant clean seed. Cultivate. Plant hoed crops. If plant seeds, burn.
St. John's-wort	July to September	July to October	Cut close to surface. Prevent flowering.
Smartweed	July to October	August to November	Prevent seedage. Cultivate when plants are young.
Sorrel	May to September	June to November	Keep cut close. Prevent seed production. Cultivate.
Sow thistle	June to August	July to September	Fall plowing. Plant infected fields to hoed crops. Prevent seeding.
Squirrel tail grass	July to September	June and August	Prevent seedage. Cultivate. Pull by hand.

FIG. 255.—Mallow. 1, Top of plant; 2, seedling; 3, seedling somewhat older; 4, separate fruit; 5, seed enlarged.

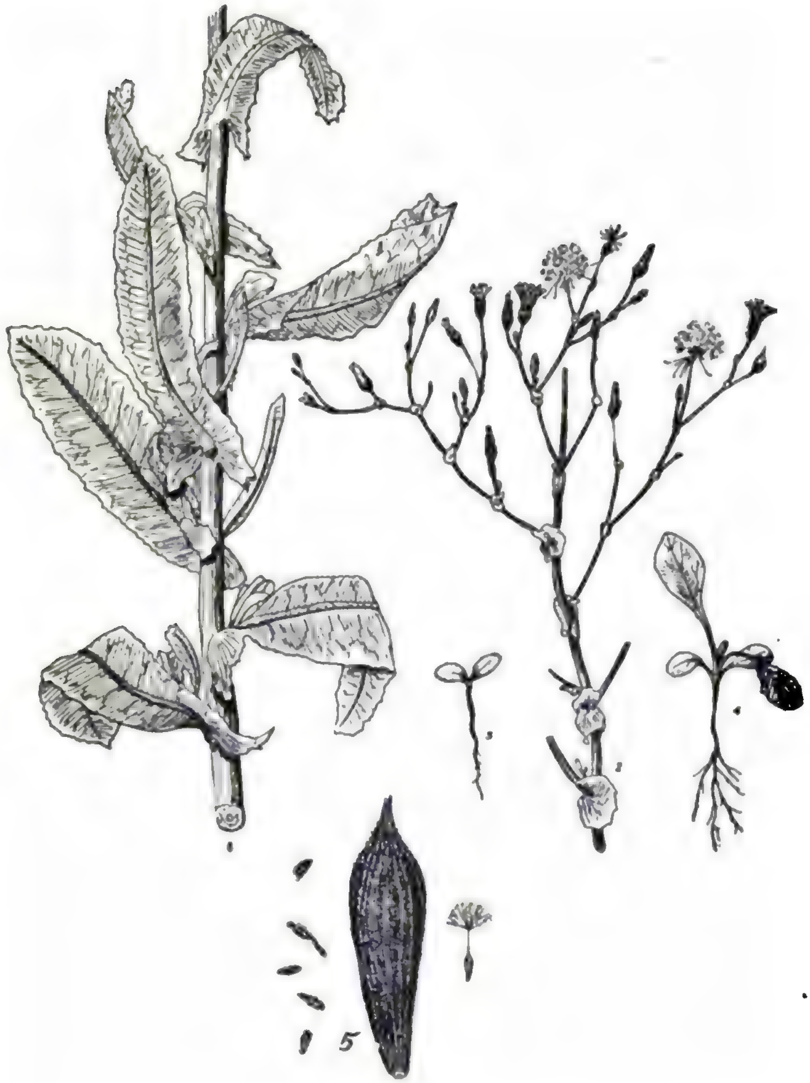

FIG. 256.—Prickly lettuce. 1, Section of plant showing leaf arrangement; 2, top of plant; 3, seedling; 4, seedling somewhat older; 5, seed natural size and enlarged.

Fig. 257.—White cockle, showing top of plant and root system, also a separate flower and mature pod.

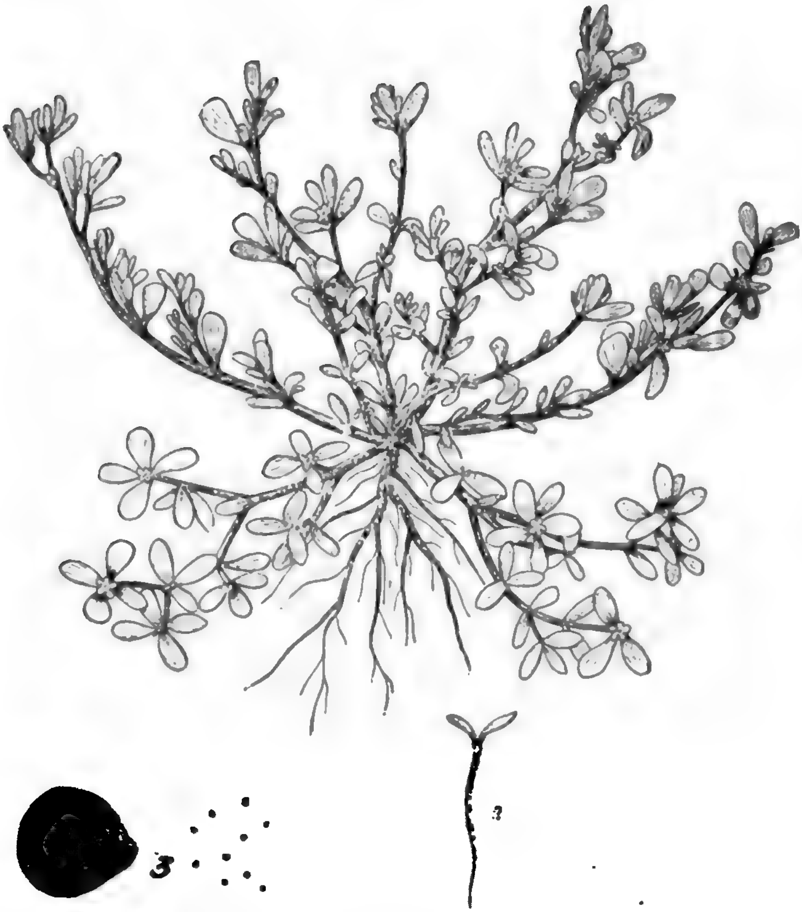

FIG. 258.—Purslane. 1, Entire plant; 2, seedling; 3, seed natural size and enlarged.

METHODS OF CONTROL—*Continued*

COMMON NAME	TIME OF FLOWERING	SEED TIME	CONTROL
Canada thistle	June and August	July to September	Fall plowing. Cultivate. Prevent seedage.
Bull thistle	July to October	August to November	Cut off below crown. Prevent seedage. Keep mowed close.
Wild carrot	June to September	August to November	Prevent seedage. Cut below crown. Plant hoed crops. Hand pull.
Wild oats	July	July to August	Plow deeply. Plant hoed crops.
Wild onion	June	....	Fall plowing (deep). Plant hoed crops and lime the soil. Hand pull.
Winter cress	April to June	June to August	Cultivate early in the spring. Prevent seedage.

To spray one acre { 12 lbs. copper sulphate to 50 gallons of water.
100 lbs. iron sulphate to 50 gallons of water.
125 lbs. salt to 50 gallons of water.

Many of the dates for the period of bloom and seedage are taken from *Manual of Weeds*, by Ada Georgia, Macmillan Co.

CHAPTER XXXVII

STANDARD WEIGHTS AND MEASURES AND OTHER VALUABLE INFORMATION*

WEIGHTS AND MEASURES

TROY WEIGHT

24 grains	1 pwt.
20 pwt.	1 ounce
12 ounces	1 pound

Used for weighing gold, silver and jewels

APOTHECARIES' WEIGHT

20 grains	1 scruple
3 scruples	1 dram
8 drams	1 ounce
12 ounces	1 pound

The ounce and pound in this are the same as in Troy Weight.

AVOIRDUPOIS WEIGHT

27 11/32 grains	1 dram
16 drams	1 ounce
16 ounces	1 pound
25 pounds	1 quarter
4 quarters	1 cwt.
2,000 pounds	1 short ton
2,240 pounds	1 long ton

DRY MEASURE

2 pints	1 quart
8 quarts	1 peck
4 pecks	1 bushel
36 bushels	1 chaldron

LIQUID MEASURE

4 gills	1 pint
2 pints	1 quart
4 quarts	1 gallon
31½ gallons	1 barrel
2 barrels	1 hogshead

TIME MEASURE

60 seconds	1 minute
60 minutes	1 hour
24 hours	1 day
7 days	1 week
28, 29, 30, or 31 days	1 calendar month

(30 days, 1 month in computing interest.)

365 days	1 year
366 days	1 leap year

CIRCULAR MEASURE

60 seconds	1 minute
60 minutes	1 degree
30 degrees	1 sign
90 degrees	1 quadrant
4 quadrants, 12 signs, or 360 degrees	1 circle

MARINER'S MEASURE

6 feet	1 fathom
120 fathoms	1 cable length
7½ cable lengths	1 mile
5,280 feet	1 statute mile
6,085 feet	1 nautical mile

LONG MEASURE

12 inches	1 foot
3 feet	1 yard
5½ yards	1 rod
40 rods	1 furlong
8 furlongs	1 statute mile
3 miles	1 league

CLOTH MEASURE

2¼ inches	1 nail
4 nails	1 quarter
4 quarters	1 yard

PAPER MEASURE

24 sheets	1 quire
20 quires	1 ream (480 sheets)
2 reams	1 bundle
5 bundles	1 bale

MISCELLANEOUS

3 inches	1 palm
4 inches	1 hand
6 inches	1 span
18 inches	1 cubit
21.8 inches	1 Bible cubit
2.5 feet	1 military pace

SQUARE MEASURE

144 square inches	1 square foot
9 square feet	1 square yard
30¼ square yards	1 square rod
40 square rods	1 rood
4 roods	1 acre
640 acres	1 square mile

SURVEYOR'S MEASURE

7.92 inches	1 link
25 links	1 rod
4 rods	1 chain
10 sq. chains or 160 sq. rods	1 acre
640 acres	1 square mile
36 sq. miles (6 miles square)	1 township

CUBIC MEASURE

1,728 cubic inches	1 cubic foot
27 cubic feet	1 cubic yard
128 cubic feet	1 cord (wood)
40 cubic feet	1 ton (shipping)
2,150.42 cubic inches	1 standard bushel
268.8 cubic inches	1 standard gallon
1 cubic foot	About 4/5 of a bushel

* Courtesy of Doubleday, Page and Company.

Weights for barn use.— Frequently the farmer wishes to feed a given weight of this, that or the other stuff and has no scales at hand to weigh it. If he has a quart measure handy, he can use it to measure out the required weight. The quart weight of various feeds is as follows:

Cottonseed meal 1.5 pounds; linseed meal, old process, 1.1 pounds; gluten meal, 1.7 pounds; gluten feed, 1.2 pounds; wheat bran, coarse, .5 pound; wheat middlings, coarse, .8 pound and fine, 1.1 pounds; mixed wheat feed, .6 pound; cornmeal, 1.5 pounds; oats, 1.2 pounds; rye bran, .6 pound; H. O. dairy feed, .7 pound, and Victor corn feed, .7 pound per quart.

Miscellaneous estimates.— From seven to twelve bushels of apples are required for a barrel of cider.

A bushel of average apples gives from six to seven pounds of evaporated product.

Raspberries contain from one and one-half to three pounds of seed to the bushel.

A pint of garden blackberries weighs about one pound.

Good clusters of American grapes weigh on an average from one-half to three-fourths of a pound, while extra good clusters will reach a pound and a half. Clusters have been reported which weighed two pounds.

A bushel of sweet corn ears, "in the milk," with the husks which come from it, weighs from fifty to seventy pounds.

There are about five thousand honey bees in a pound.

Measuring in bulk.— Two cubic feet of sound, dry corn in the ear will make a bushel shelled. To get the quantity of shelled corn in a crib of corn in the ear, measure the length, breadth and height of the crib, inside of the rail; multiply the length by the breadth, and the product by the height; then divide the product by two, and you have the number of bushels in the crib.

To find out the number of bushels of apples, potatoes, etc., in a bin, multiply the length, breadth and thickness together, and this product by eight, and point one figure in the product for decimals. To find the amount of hay in a mow, allow five hundred and twelve cubic feet for a ton, and it will come out very near correct.

Practical measurement of land.— To find the number of acres in any rectangular piece of land, multiply the length and breadth in rods together, and divide by one hundred and sixty (the number of square rods in an acre), and the result will be the required answer.

When one side and perpendicular to that side from the oppo-

site angle are given, take one-half the product of the side and perpendicular, and divide by one hundred and sixty.

When three sides are given, from half the sum of the three sides subtract each side separately; multiply the half sum and the three remainders together; the square root of the product divided by one hundred and sixty will give the number of acres in the field.

When the piece of land is in the shape of a trapezoid, take one-half the product of the sum of the parallel sides and the perpendicular between those sides, and divide by one hundred and sixty.

To find the area of any straight-sided piece of land, divide the latter into convenient parts, find the area of every part, and the sum will be the area of the field.

In general, the parts into which the field can be most conveniently divided will be triangles, but in some cases we may have a rectangle or a trapezoid, whose areas may be found by the preceding rules. The area of a right-angle triangle equals one-half the product of the two short sides.

To ascertain the weight of cattle.— Measure the girth close behind the shoulder, and the length from the fore part of the shoulder blade along the back to the bone at the tail, which is in a vertical line with the buttock, both in feet. Multiply the square of the girth, expressed in feet, by five times the length, and divide the product by twenty-one; the quotient is the weight, nearly, of the four quarters, in imperial stones of fourteen pounds avoirdupois. For example, if the girth be seven feet, and the length five and one-quarter feet, we shall have 6 x 6 — 36 and 5¼ x 5 — 26¼; then 36 x 26¼ — 945, and this divided by twenty gives forty-five stones exactly. It is to be observed, however, that in very fat cattle the four quarters will be about one-twentieth more, while in those in a very lean state they will be one-twentieth less than the weight obtained by the rule.

Rule for measuring corn.— A heaped bushel contains 2,748 cubic inches. To find the number of bushels of corn in a crib it is therefore necessary merely to multiply together the length, width and height in inches and divide the product by 2,748. The number of bushels of shelled corn will be two-thirds of the quotient. If the sides of the crib are slanting, it will be necessary to multiply together one-half the sum of the top and bottom widths, the height and length.

Rule for estimating hay.— Hay is often sold in the mow or stack where the weight has to be estimated. For this purpose

four hundred cubic feet of hay is considered a ton. The actual weight of four hundred cubic feet of hay will vary according to the quality of the hay, time of cutting, position in the mow, etc. For making an estimate in a given case multiply together the length, breadth and height of the mow or stack in feet and divide the product by four hundred. The quotient will be the number of tons.

CONVENIENT LAND MEASURES

10 rods by 16 rods	1 acre	40 yards by 121 yards	1 acre
8 rods by 20 rods	1 acre	220 feet by 198 feet	1 acre
5 rods by 32 rods	1 acre	110 feet by 396 feet	1 acre
4 rods by 40 rods	1 acre	60 feet by 726 feet	1 acre
5 yards by 968 yards	1 acre	120 feet by 363 feet	1 acre
10 yards by 484 yards	1 acre	300 feet by 145.2 feet	1 acre
20 yards by 242 yards	1 acre	400 feet by 108.9 feet	1 acre

AMOUNT OF BARBED WIRE REQUIRED FOR FENCES
Based upon each pound measuring one rod

	ONE LINE	TWO LINES	THREE LINES
1 square acre	50 2/3 lbs.	101½ lbs.	152 lbs.
1 square mile	1,280 lbs.	2,564 lbs.	3,840 lbs.
1 side of square mile	320 lbs.	640 lbs.	960 lbs.
1 rod in length	1 lb.	2 lbs.	3 lbs.
100 rods	100 lbs.	200 lbs.	300 lbs.
100 feet	6 1/16 lbs.	12½ lbs.	18 3/16 lbs.

CUSTOMARY WEIGHTS PER BUSHEL OF SEEDS

KIND OF SEED	POUNDS PER BUSHEL	KIND OF SEED	POUNDS PER BUSHEL
Alfalfa	60	Clover:	
Amber cane	45–60	Alsike	60
Bent grass:		Crimson	60
Creeping	15	Egyptian	60
Rhode Island	15	Mammoth	60
Bermuda grass	15	Red	60
Bird's-foot clover	60	White	60
Bitter vetch	60	Cowpea	56–60
Blue grass:		Crested dog's tail	14–30
Canada	14–20	Fescue:	
Kentucky	14–30	Hard	12–16
Texas	14	Meadow	14–24
Broad bean	50–60	Red	12–15
Brome, awnless	10–14	Sheep's	16
Broom corn	45–60	Tall	14–24
Bur clover:		Various leaved	15
Hulled	60	Flat pea	50–60
Unhulled	8–10	Flax	48–56
Spotted	60	Hemp	40–60
Castor bean	46–60		

CUSTOMARY WEIGHTS PER BUSHEL OF SEEDS — *Continued*

KIND OF SEED	POUNDS PER BUSHEL	KIND OF SEED	POUNDS PER BUSHEL
Japan clover:		Peanut	20–30
Hulled	60	Rape, winter	50–60
Unhulled	18–25	Redtop:	
Johnson grass	14–28	Chaff	10–14
Kafir corn	50–60	Fancy	25–40
Lentil	60	Rescue grass	12–28
Lupine, white	50–60	Rice	43–45
Meadow foxtail	7–14	Rye grass:	
Meadow grass:		English	28
Fowl	11–14	Italian	12
Rough-stalked	14–20	Sainfoin	14–32
Wood	14–24	Serradelia	28–36
Millet:		Soy bean	58–60
Barnyard	30–60	Spelt	40–60
Broom corn	45–60	Sunflower	24–50
Common	48–50	Sweet clover:	
German	48–50	Hulled	60
Golden Wonder	48–50	Unhulled	33
Hungarian	48–50	Sweet corn (according to	
Pearl	48–56	variety)	36–56
Milo maize	50–60	Sweet vernal, perennial	6–15
Oat grass:		Teosinte	40–60
Tall	10–14	Timothy	45
Yellow	7–14	Velvet bean	60
Orange cane	45–60	Vetch:	
Orchard grass	10–18	Hairy	50–60
Pea:		Spring	60
Field	60	Water grass, large	14
Garden, smooth	60	Wild rice	15–28
Garden, wrinkled	56	Yellow trefoil	60

LEGAL WEIGHTS OF VARIOUS COMMODITIES
Minimum weight by U. S. Statute

	POUNDS PER BUSHEL		POUNDS PER BUSHEL
Apples, dried	26	Lime, unslaked	30
Barley	48	Malt	38
Beans, castor	46	Millet seed	50
Beans, white	60	Oats	32
Bluegrass seed	44	Onions	57
Bran	20	Peaches, dried	3
Buckwheat	48	Peas	60
Clover seed	60	Peas, ground, pea meal	42
Coal	80	Potatoes, Irish	60
Corn, shelled	56	Potatoes, sweet	55
Corn, in the ear	70	Rye	56
Corn meal	48	Salt, fine	167
Flaxseed	56	Salt, coarse	151
Hair, plastering	8	Timothy seed	46
Hemp seed	44	Turnips	55
Hungarian grass seed	50	Wheat	60

FRUIT PACKAGES

Sizes and weights of packages for deciduous fruits (California Fruit Distributors)

Cherries	11 pounds per box.
Peaches	21½ pounds per box.
Pears	50 pounds per box.
Pears for export to Europe	24 pounds per box.
Prunes	26 pounds per single crate.
Apricots	26 pounds per single crate.
Nectarines	25 pounds per single crate.
Plums	26 pounds per single crate.
Grapes	26 pounds per single crate.
Grapes	56 pounds per double crate.

IN INCHES

	DEPTH	WIDTH	LENGTH
Cherries, box	2¾	9	19¾
Peaches, box	5	11¾	19¾
Pears, box	9	11¾	19¾
Pears, for export to Europe, box	4½	11¾	19¾
Apricots, single crate	5	16	17½
Nectarines, single crate	5	16	17½
Prunes, single crate	5	16	17½
Plums, single crate	5	16	17½
Grapes, single crate	5	16	17½
Grapes, double crate	11¼	16	17½

Chautauqua, N. Y., grape figures.— The grapes are shipped in eight-pound Climax baskets, which weigh, when not filled, twenty ounces. A carload is two thousand eight hundred to three thousand baskets. A girl will pack from one hundred to one hundred and fifty baskets per day. One and one-fourth cents per basket is paid for picking and packing. An average acre of Concord grapes yields about five hundred baskets. The average annual cost of cultivating the vineyard up to picking time is eight dollars. The expense of picking, packing, packages, and carting is about twenty-eight dollars for the five hundred baskets. In bulk the grapes are shipped in crates of thirty-eight pound capacity; cost of picking in crates is about two cents for quantity representing two and one-half baskets. The bunches are cut from the vines with shears made for the purpose. In the packing house the bunches are trimmed.

Citrus fruits.— The specifications of the boxes used in the packing of California oranges are shown in the railroad tariffs with an estimated weight, and the box so shown is the only one used. The inside dimensions are eleven and one-half inches by

eleven and one-half inches by twenty-four inches, the slats are twenty-six inches long, but the thickness of the ends and center-pieces is two inches, making the inside length twenty-four inches. No. 2 Jumbo orange box, eleven and one-half inches by twelve and one-half inches by twenty-four inches.

The California box for lemons shown in the tariff is ten and one-half inches by fourteen inches by twenty-five inches. Recently the lemon shippers adopted a new-sized box which packs lemons to better advantage, and this new box will be used as soon as the accumulation of old stock is exhausted, and the tariffs will be changed to show its dimensions, which are ten and three-eighths inches by thirteen and one-half inches by twenty-five inches inside. Old box, 3675 cubic inches; new box, 3501 9/16 cubic inches.

Florida orange box, twelve by twelve by twenty-four and one-half inches inside. Half box, five and five-eighths by twelve by twenty-four and one-half inches.

Apple boxes (W. A. Taylor).— The following table shows legal weight to the bushel of apples and legal sizes of the apple boxes and barrels; also the usual standard (not legal) size of apple boxes and the heaped-bushel expressed in cubic inches in such states as have expressed the capacity of the heaped bushel in that form.

All these boxes when actually used are subject to considerable variation in capacity, resulting from the use or non-use of cleats under the covers.

APPLE LEGISLATION

Box and barrel sizes and weights per bushel.

STATE	POUNDS PER BU.	BOX SIZE	BARREL SIZE
Arkansas	Apples, green, 50	20″ × 12″ × 9″ (lawful bushel measure).	
Connecticut	Apples 48	....	2,160 cu. in.
Florida	Apples, green, 48		
Iowa	Apples 48		
Kansas	Apples, green, 48		
Maine	Apples 44	20″ × 11″ × 10″ =2,250 cu. in. (stand. bu. box)	Heads, 16½″ Stave, 28½″ Bulge, 64″ Equals 3 bu.
Maryland	....	2,212 cu. in.....	6,253¾ cu. in.
Massachusetts	Apples 48		
Michigan	Apples 48	....	Heads, 16½″ Stave, 27″, or Flour barrel size.

APPLE LEGISLATION — *Continued*

STATE	POUNDS PER BU.	BOX SIZE	BARREL SIZE
Minnesota	Apples, green, 50		
Missouri	Apples 48	....	Heads, 17¼" Stave, 28½" Diameter center inside, 20½"
Nebraska	Apples, green, 48		
New Jersey	Apples 50		
New York	Apples 48	....	Heads, 17⅛" Stave, 28½" Bulge, 66"
Oregon "standard box"	Apples 45	18" × 11½" × 10½"	2,173⅛ cu. in.
Oregon "special box"	....	20" × 11" × 10"	2,200 cu. in.
Tennessee	Apples, green, 50	....	2½ bushels.
Texas	Apples 50		
Vermont	Apples 46		
Virginia	Apples 45	....	Heads, 17⅛" Stave, 27½" Bulge, 64"
Washington	Apples, green, 45	18" × 11½" × 10½".	
Wisconsin	Apples 48	....	100 quarts.

OTHER APPLE BOX SIZES

California (40 pound)	20¾" × 10⅝" × 9⅛"	1,965 cubic inches
California (50 pound)	20¾" × 11¼" × 10¾"	2,393 cubic inches
Canadian (legal)	20" × 11" × 10"	2,200 cubic inches
Colorado	18" × 11" × 12"	2,376 cubic inches
Washington "special"	20" × 11" × 10"	2,200 cubic inches
Northwestern "special"	20" × 12" × 10"	2,400 cubic inches

LEGAL HEAPED BUSHEL CAPACITIES (APPLES)

Connecticut (heaped bushel)	2,564 cubic inches
Kansas (heaped bushel)	2,564 cubic inches
Washington (heaped bushel)	2,564 cubic inches

BOX PACKING OF APPLES IN WASHINGTON AND OREGON (C. S. Wilson)

Boxes.— (*a*) Standard, ten and one-half inches by eleven and one-half inches by eighteen inches inside measurement.

(*b*) Special, ten inches by eleven inches by twenty inches inside measurement.

Material.—Ends, three-quarter inch; sides, three-eighths inch; tops and bottoms, two pieces each, one-quarter inch thick. There should be two cleats for each top and bottom. The sides of the box should be nailed with four nails at each end of each side. The cleats should be put neatly on the box, and four nails driven through them, and through the top or bottom into the ends. Five-penny cement-coated nails are preferable.

Wrapping paper.— Any of the following grades may be used: Light manilla, heavy-weight tissue, or "white news." The size of the wrapper will vary somewhat, according to the size of the apple. Two sizes should be ordered, eight inch by ten inch and ten inch by ten inch. The approximate cost of this wrapping paper would be, light manilla, and heavy-weight tissue, four and one-half or five cents per pound, or about thirty-five cents per thousand sheets; "white news," three and one-half cents per pound, or about thirty cents per thousand sheets.

Lining paper.— The lining paper is made from "white news," size eighteen inches by twenty-four inches. The approximate cost of this paper would be three and one-half cents per pound, or about one dollar and fifteen cents per thousand sheets.

Layer paper.— In some cases it is necessary to use layer paper to raise the pack in order to come out right at the top. For this purpose use colored tag-board, size seventeen and one-quarter inches by eleven inches, or nineteen and one-half inches by ten and one-half inches, according to the box. The approximate cost of this paper would be about seven dollars and fifty cents per thousand sheets. The above prices were quoted before the war.

Packing.— Before placing the apples on the packing table they are usually graded into different sizes. This facilitates very much the work of the packers. A sizer may be used at the beginning, but one soon trains the eye to recognize the different grades. The diagonal pack is preferable, although one is forced to use the straight pack for a few sizes.

The following table was used at Hood River, Oregon, in the fall of 1910. (C. I. Lewis, in "Better Fruits"):

TABLE OF COMMERCIAL BOX PACKS

SIZE—EXPRESSED IN NUMBER OF APPLES PER BOX	TIER	PACK	NUMBER OF APPLES IN ROW	NUMBER OF LAYERS IN DEPTH	BOX USED
45	3	3 St.	5–5	3	Standard
54	3	3 St.	6–6	3	Special
63	3	3 St.	7–7	3	Special
64	3½	2–2 Diag.	4–4	4	Standard
72	3½	2–2 Diag.	4–5	4	Standard
80	3½	2–2 Diag.	5–5	4	Standard
88	3½	2–2 Diag.	5–6	4	Standard
96	3½	2–2 Diag.	6–6	4	Special
104	3½	2–2 Diag.	6–7	4	Special
112	3½	2–2 Diag.	7–7	4	Special
120	3½	2–2 Diag.	7–8	4	Special
128	4	4 St.	8–8	4	Special
144	4	4 St.	9–9	4	Special
150	4½	3–2 Diag.	6–6	5	Standard
163	4½	3–2 Diag.	6–7	5	Standard
175	4½	3–2 Diag.	7–7	5	Standard
188	4½	3–2 Diag.	7–8	5	Special
200	4½	3–2 Diag.	8–8	5	Special

PACKAGES FOR TRUCK CROPS, INCLUDING STRAWBERRIES

L. C. CORBETT

Potatoes.— Truck crop potatoes are shipped from the Atlantic seaboard points in ventilated barrels holding two and three-quarter bushels; from the Mississippi Valley and Gulf States in sacks holding one hundred and ninety-five pounds; from Maine in sacks holding one hundred and sixty-five pounds, and from California and Colorado sections in sacks holding one hundred pounds (everything in this region being sold by net weight rather than by bushel). In northern sections of Vermont, New York, Michigan, Wisconsin, potatoes are largely sold in bulk by weight at so much per bushel. During the cooler portions of the year sweet potatoes are shipped in standard, double-headed barrels after the potatoes are cured.

Cabbages.— From the Atlantic seaboard states south of Baltimore are shipped either in crates or ventilated barrels holding two and three-quarter bushels. These crates are usually flat, about three feet long. In the North crates three feet square are often used for shipment of cabbage, but the general crop grown for storage and for the manufacture of kraut is sold in bulk by the ton (heads trimmed).

Cauliflower.— From the southern fields is almost universally

shipped in ventilated barrels packed in excelsior, barrels being standard truck-crop-barrel of two and three-quarter bushels. California package is a flat carrier holding one dozen or one and one-half dozen heads.

Brussels sprouts are packed in quart cups, in crates holding thirty-two cups.

Tomatoes from eastern states in crates, holding about one bushel, similar to those used for the shipment of muskmelons, dimensions about twelve inches by twelve inches by twenty-two inches. Some fruits arrive from Florida in this type of package, but most tomatoes come in six-basket carriers similar to those used for peaches. In Texas a flat, four-basket carrier, which is only one tier deep, is almost universally used.

Onions of the winter sorts are shipped either in ventilated barrels or standard sacks holding about two and three-quarter bushels, or one hundred pounds weight. The Texas Bermuda crop is universally shipped in slatted bushel crates, twenty inches long, twelve inches wide and twelve inches deep.

Celery from the Florida section is packed in flat crates usually eleven inches by twenty inches by twenty-four inches. The California package is a cubical crate, twenty-four inches by twenty-four inches by twenty inches. Most Eastern sections use the California type of package.

Muskmelons from most sections arrive in a veneer crate very similar in shape to the orange box, but somewhat smaller, the dimensions being approximately twelve inches by twelve inches by twenty-two inches. Some sections ship melons in sixty-quart and thirty-two quart berry crates, while a small percentage of the crop arrives in flat carriers arranged to hold a single layer of melons. These carriers usually contain eighteen to twenty-four melons.

Eggplants are usually wrapped in paper and forwarded in sixty-quart berry crates.

Peas are shipped largely in five-eighths standard Delaware baskets with ventilated wood covers, or in barrel-high Delaware baskets with ventilated wood covers.

String beans (snap) are shipped either in one-half bushel or barrel-high Delaware baskets.

Beets are usually pulled when two or two and one-half inches in diameter and tied in bunches of three to six beets and packed in sixty-quart berry crates, ventilated barrels, or barrel-high Delaware baskets, depending on the market to which they are consigned.

Water-cress is either marketed in bunches or in bulk in iced barrels, or in iced barrel-high Delaware baskets.

Cucumbers are marketed from the trucking region either in ventilated barrels, barrel-high, or half bushel Delaware baskets; and in the pickle-growing districts they are marketed in bulk by the hundred weight.

Lettuce from the truck-farming district is marketed in either half bushel or barrel-high Delaware baskets or in ventilated barrels. The barrel package is not, however, generally used. The flat carrier of the same type as that used in California for shipping cauliflower is now extensively used for lettuce.

Spinach is almost universally marketed from the truck-farming sections in ventilated barrels. A small quantity is received in barrel-high Delaware baskets.

Okra is marketed either in six-basket carriers or in a special flat carrier without baskets, in which the pods are carefully arranged one layer wide. These packages are usually about two feet long.

Green peppers are almost universally marketed in six-basket carriers.

Radishes are tied in bunches and packed in one-bushel or barrel-high Delaware baskets, as a rule. A few are marketed in ventilated barrels.

Strawberries are offered in quart cups, either in sixty-quart crates from the Carolina and Norfolk region, or in twenty-four or thirty-two quart crates from other regions, the thirty-two quart being more universally used than any other.

Dimensions.— The truck barrel is: Length of stave, twenty-eight and one half inches, between heads, twenty-six inches; diameter of heads, seventeen and one-half inches; bulge of the barrel, sixty-four inches over all; thickness of stave, four-tenths inch.

The eggplant and squash crate has a head eleven inches by fourteen inches, and is twenty-four inches long.

The half-barrel basket commonly used in the Norfolk region is twenty inches high, nine and one-half inches at the bottom, and slats twenty-six inches long, outside measure, making it ten inches by fifteen inches by seventeen inches by twenty-four inches inside.

The one-half barrel lettuce basket, called the "Delaware barrel-high basket" is sixteen inches inside diameter at the top, nine inches inside diameter at the bottom, and twenty-seven

inches high. The flat carrier lettuce-box is seven and one-half inches by eighteen inches by twenty-two inches.

The cabbage crate which comes from Norfolk is eleven and one-half inches by eighteen inches on the heads and is thirty-six inches long, with a partition in the middle.

The three-peck basket which is used early in the season for shipping peas, beans, cucumbers, and crookneck squashes is twenty inches high, fourteen inches inside measure at the top, and eight and one-half inches inside measure at the bottom.

The flat onion crate with partition in the center has sixteen-inch by seven-inch heads, and is twenty-four inches long.

WEIGHTS OF EVERYDAY THINGS

A barrel of flour weighs one hundred and ninety-six pounds.

A barrel of salt weighs two hundred and eighty pounds.

A barrel of beef weighs two hundred pounds.

A barrel of pork weighs two hundred pounds.

A barrel of fish weighs two hundred pounds.

A keg of powder equals twenty-five pounds.

A stone of lead or iron equals fourteen pounds.

A pig of lead or iron equals twenty-one and one-half stone.

Anthracite coal broken — cubic foot averages, fifty-four pounds.

A ton loose occupies forty to forty-three cubic feet.

Bituminous coal broken — cubic foot averages, forty-nine pounds.

A ton loose occupies forty to forty-eight cubic feet.

Cement (hydraulic) Rosendale, weight, per bushel, seventy pounds.

Cement (hydraulic) Louisville, weight per bushel, sixty-two pounds.

Cement (hydraulic) Portland, weight per bushel, ninety-six pounds.

Gypsum, ground, weight per bushel, seventy pounds.

Lime, loose, weight per bushel, seventy pounds.

Lime, well shaken, weight per bushel, eighty pounds.

Sand, at ninety-eight pounds per cubic foot, per bushel, one hundred and twenty-two and one-half pounds.

18.29 bushels equals a ton; 1.181 tons a cubic yard.

WEIGHTS AND HOUSEHOLD MEASURES

Forty-five drops of water is a teaspoonful.

One teaspoonful equals one fluid dram.

One dessertspoonful equals two teaspoonfuls, or two drams.

One tablespoonful equals two dessertspoonfuls, or four teaspoonfuls.

Two tablespoonfuls equals eight teaspoonfuls, or one fluid ounce.

One common size wineglassful equals two ounces or one-half gill.

One common size tumbler holds one-half pint.

A small teacup is estimated to hold four fluid ounces or one gill.

One pound of wheat is equal to about one pint.

One pound and two ounces of Indian meal is equal to one quart.

One pound of sugar is equal to about one pint.

A pint of pure water is about a pound.

Table to estimate wall paper.— An ordinary single roll of wall paper made in America is eight yards long and eighteen inches wide. A double roll is sixteen yards long. Cartridge or Ingrain papers are thirty inches wide. Borders and friezes are usually either nine or eighteen inches wide, and eighteen yards long. Where the border is but nine inches wide, two widths are usually furnished on a roll.

To use this table, first measure the length and width of the room, add them together and multiply by two. You then have the length of the four sides of the room. Then measure the height of the room and add, referring to the table, find in the first column the figure nearest to the one that represents the sum of the four sides. Follow this line across to the column that corresponds to the height of your room. The number will be the number of single rolls of wall paper that will be needed to cover the walls, not making any allowance for doors or windows. For each door or window deduct half a single roll. For mantels and fireplaces deduct a single roll for each thirty-six square feet of surface.

NUMBER OF FEET AROUND ROOM	SIDE WALLS Number of single rolls required					BORDER Number of single rolls		CEILING Number of single rolls required
	For height of 8 feet	For height of 9 feet	For height of 10 feet	For height of 11 feet	For height of 12 feet	9-inch border	18-inch border	
28	7	8	9	10	11	1	2	2
32	8	9	10	11	12	1	2	2
36	9	10	11	12	13	1	2	3
40	10	11	12	14	15	1	2	4
44	11	12	14	15	16	1	2	4
48	12	13	15	16	18	2	3	5
52	13	15	16	18	19	2	3	6
56	14	16	17	19	21	2	3	6
60	15	17	19	20	22	2	3	7
64	16	18	20	22	24	2	3	8
68	17	19	21	23	25	2	3	10
72	18	20	22	24	27	2	4	11
76	19	21	23	26	28	2	4	12
80	20	22	25	27	30	2	4	13
84	21	23	26	28	31	2	4	14
88	22	24	27	30	32	2	4	15
92	23	26	28	31	34	3	5	16
96	24	27	30	32	35	3	5	18
100	25	28	31	34	37	3	5	19
104	26	29	32	35	38	3	5	21
108	27	30	33	36	40	3	5	22

Number of Plants for an Acre

DISTANCE APART	NUMBER OF PLANTS	DISTANCE APART	NUMBER OF PLANTS	DISTANCE APART	NUMBER OF PLANTS
3 x3 inches	696,960	4 x4 feet	2,722	13 x13 feet	257
4 x4 inches	392,040	4½x4½ feet	2,151	14 x14 feet	222
6 x6 inches	174,240	5 x1 feet	8,712	15 x15 feet	193
9 x9 inches	77,440	5 x2 feet	4,356	16 x16 feet	170
1 x1 foot	43,560	5 x3 feet	2,904	16½x16½ feet	160
1½x1½ feet	19,360	5 x4 feet	2,178	17 x17 feet	150
2 x1 feet	21,780	5 x5 feet	1,742	18 x18 feet	134
2 x2 feet	10,890	5½x5½ feet	1,417	19 x19 feet	120
2½x2½ feet	6,960	6 x6 feet	1,210	20 x20 feet	108
3 x1 feet	14,520	6½x6½ feet	1,031	25 x25 feet	69
3 x2 feet	7,260	7 x7 feet	881	30 x30 feet	48
3 x3 feet	4,840	8 x8 feet	680	33 x33 feet	40
3½x3½ feet	3,555	9 x9 feet	537	40 x40 feet	27
4 x1 feet	10,890	10 x10 feet	435	50 x50 feet	17
4 x2 feet	5,445	11 x11 feet	360	60 x60 feet	12
4 x3 feet	3,630	12 x12 feet	302	66 x66 feet	10

Suitable Distances for Planting

Apples — Standard	32 to 35 feet apart each way
Apples — Dwarf (bushes)	10 feet apart each way
Pears — Standard	16 to 20 feet apart each way
Pears — Dwarf	10 feet apart each way
Cherries — Standard	18 to 20 feet apart each way
Cherries — Dukes and Morrellos	16 to 18 feet apart each way
Plums — Standard	16 to 20 feet apart each way

SUITABLE DISTANCES FOR PLANTING — *Continued*

Peaches	16 to 18 feet apart each way
Apricots	16 to 18 feet apart each way
Nectarines	16 to 18 feet apart each way
Quinces	10 to 12 feet apart each way
Currants	3 to 4 feet apart each way
Gooseberries	3 to 4 feet apart each way
Raspberries	3 to 5 feet apart each way
Blackberries	6 to 7 feet apart each way
Grapes	8 to 12 feet apart each way

To estimate the number of plants required for an acre, at any given distance, multiply the distance between the rows by the distance between the plants, which will give the number of square feet allotted to each plant, and divide the number of square feet in an acre (43,560) by this number. The quotient will be the number of plants required.

USEFUL INFORMATION

To find the diameter of a circle multiply circumference by .31831.

To find circumference of a circle multiply diameter by 3.1416.

To find area of a circle multiply square of diameter by .7854.

To find surface of a ball multiply square of diameter by 3.1416.

To find side of an equal square multiply diameter by .8862.

To find cubic inches in a ball multiply cube of diameter by .5236.

Doubling the diameter of a pipe increases its capacity four times.

Double riveting is from sixteen to twenty per cent stronger than single.

One cubic foot of anthracite coal weighs about fifty-eight pounds.

One cubic foot of bituminous coal weighs from forty-seven to fifty pounds.

One ton of coal is equivalent to two cords of wood for steam purposes.

A gallon of water (U. S. Standard) weighs eight and one-half pounds and contains two hundred and thirty-one cubic inches.

There are nine square feet of heating surface to each square foot of grate surface.

A cubic foot of water contains seven and one-half gallons, one thousand seven hundred and twenty-eight cubic inches, and weighs sixty-two and one-half pounds.

Each nominal horsepower of a boiler requires thirty to thirty-five pounds of water per hour.

Studding.— Estimate the number of lineal feet of partitions and outside walls and allow one stud for each foot. If set to the customary sixteen-inch centers, this will give the extra studs necessary for doubling up around doors and windows.

Covering capacity of shingles.— Shingles of the average size of four by sixteen inches are taken as a basis of calculation:

100 square feet will require laid 4 inches to the weather...	900
100 square feet will require laid 4½ inches to the weather...	800
100 square feet will require laid 5 inches to the weather...	720

One thousand shingles require three and one-half pounds of four-penny nails.

Five to ten per cent should be allowed to these figures to cover waste and shortage.

Short Cuts in Estimating Lumber for Windows and Doors

	Feet
The average jamb casing for windows ⅞ inch finish........	10
The average jamb casing for windows 1¼ inch finish........	12
The average jamb casing for doors ⅞ inch finish	10
The average jamb casing for doors 1¼ inch finish	12
The average jamb casing for doors 1½ inch finish	15
The average jamb casing for doors 2 inch finish	20
Outside casings for windows ⅞ inch finish................	8
Outside casings for windows 1¼ inch finish................	10
Outside casings for doors ⅞ inch finish..................	10
Outside casings for doors 1¼ inch finish..................	12
Inside window trim lineal measure..........................	15
Inside door trim lineal measure for one side................	16
Inside door trim lineal measure for two sides................	32

On estimating flooring and ceiling boards the following should be allowed for matching: One-third for boards of three-inch width; one-quarter more for boards of four-inch width; and one-fifth for boards of six-inch width.

For beveled siding make no allowance for openings and add one-quarter more for four-inch and one-sixth for six-inch.

POST-OFFICE REGULATIONS — DOMESTIC

In addition to the States and Territories, domestic rates apply to the Island Possessions, the Panama Canal Zone, and Shanghai, China.

All mail matter except second-class publications mailed by publishers or news agents and third and fourth-class matter mailed under permits must be wholly or in part prepaid by postage stamps.

Letters and Postal Cards — First Class

Letters or other matter wholly or partly in writing or typewriting, except as hereinafter provided, and all matter sealed or closed against inspection, except original packages of proprietary articles in simplest mercantile form, and seeds and like articles in transparent envelopes, to be sent beyond the office where deposited, or for local delivery when mailed in a letter-carrier post-office or rural delivery — one rate must be prepaid, and article must not weigh over four pounds — *each ounce or fraction*........ .02
Drop or local letters deposited in other than a letter-carrier office or rural delivery — *each ounce or fraction*........ .01
Registered Letters, in addition to the regular postage which must be fully prepaid................................ .10
Special (or Immediate) Delivery Letters, in addition to regular postage, a *special stamp or ten cents in ordinary stamps* and marked *special delivery*.................... .10
Postal Cards .... .01
Postal Cards, with paid reply.......................... .02
Post Cards, conforming to prescribed conditions.......... .01

Newspapers and Periodicals — Second Class

No Limit to Weight — Except to Canada (4 lbs. 6. oz.)
All Newspapers and other Periodicals, one copy to each actual subscriber, residing within the county where they are printed, wholly or in part, and published, except those deliverable at letter-carrier offices or rural delivery..... free
Newspapers and Periodicals to regular subscribers and sample copies, *each pound or fraction*................. .01
Newspapers (except weeklies) *and Periodicals* not exceeding two ounces in weight, when deposited in a letter-carrier office or rural delivery for delivery by carrier, each payable by stamps affixed.......................... .01
Periodicals over two ounces in weight, deposited as above, prepaid by postage stamps affixed, *each*................ .02
Weeklies, deliverable by carriers, at letter-carrier offices or rural delivery, *for each pound or fraction*.............. .01

The rates stated above apply only to second-class publications *mailed by the publishers* thereof or by registered news-agents.

Second-class Matter, when posted by persons other than the publisher or news-agent, *for each four ounces or fraction prepaid by stamps*.................................. .01

Miscellaneous Printed Matter, Etc.—Third Class

Pamphlets, circulars, occasional publications, photographs, proof-sheets or corrected proofs, and manuscript copy accompanying the same, and all matter on paper or card-board wholly in print, *in which the printing forms the principal use,* and not exceeding four pounds in weight, *for each two ounces or fraction*........................ 01

Books (*printed*), not over four pounds in weight (*single volumes* may be over), for *each two ounces or fraction*.. .01

Merchandise — Fourth Class

Samples of metals, ores, minerals, or merchandise, paintings in oil or water, crayon drawings, printed envelopes, bill-heads, letter-heads, blotting-paper with or without printed advertisements thereon, blank cards, photograph albums, blank books, blank labels, blank tags, playing cards; and any articles not of the other classes, and not liable to damage the mails, or injure any person, not exceeding four pounds in weight, *for each ounce or fraction thereof fully prepaid*................................. .01

Seeds, cuttings, bulbs, roots, and cions, for *each two ounces or fraction* .... .01

Registration, in addition to regular postage.............. .10

United States Money Orders

Not exceeding $100 on one order. are issued on payment of the following fees:

Not exceeding $2.50	.03
Exceeding $2.50 and not exceeding $5.00	.05
Exceeding $5.00 and not exceeding $10.00	.08
Exceeding $10.00 and not exceeding $20.00	.10
Exceeding $20.00 and not exceeding $30.00	.12
Exceeding $30.00 and not exceeding $40.00	.15
Exceeding $40.00 and not exceeding $50.00	.18
Exceeding $50.00 and not exceeding $60.00	.20
Exceeding $60.00 and not exceeding $75.00	.25
Exceeding $75.00 and not exceeding $100.00	.30

The period of gestation in animals varies considerably, but the following is an average period based on a long series of observations:

AVERAGE PERIOD OF GESTATION

Elephant	2 years
Camel	11–12 months
Ass	12 months
Mare	11 months
Cow	9 months
Sheep	5 months
Goat	5 months
Pig	3½ months
Bitch	9 weeks
Cat	8 weeks
Rabbit	30 days
Guinea pig	65 days

AVERAGE PERIOD OF INCUBATION

Chickens	20–22 days
Geese	28–34 days
Ducks	28 days
Turkeys	27–29 days
Guinea fowls	28 days
Pheasants	25 days
Ostriches	40–42 days

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